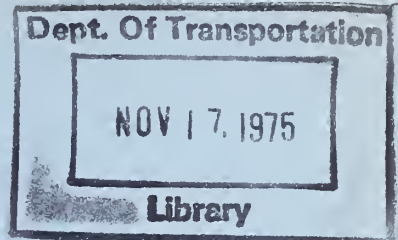


TE
662
A3
No.
FHWA-
RD-
75-69

Report No. FHWA-RD-75-69



HIGHWAY METRICATION

Vol. 2. Appendixes

D. G. Meacham and others



April 1975
Final Report

This document is available to the public
through the National Technical Information
Service, Springfield, Virginia 22161

Prepared for
FEDERAL HIGHWAY ADMINISTRATION
Offices of Research & Development
Washington, D.C. 20590

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The contents of this report reflect the views of the Ohio Department of Transportation which is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policy of the Department of Transportation. This report does not constitute a standard, specification or regulation.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear only because they are considered essential to the object of this document.

FHWA DISTRIBUTION NOTICE

Sufficient copies of this report are being distributed by FHWA Bulletin to provide a minimum of two copies to each Regional Office, one copy to each Division Office, and two copies to each State Highway Agency. Direct distribution is being made to the Division Offices.

NOV 17 1975

Technical Report Documentation Page
Library

1. Report No. FHWA-RD-75-69	2. Government Accession No.	3. Recipient's Catalog No.								
4. Title and Subtitle HIGHWAY METRICATION, V. 2 : Vol. 2. Appendixes.	5. Report Date April 1975	6. Performing Organization Code								
7. Author(s) D. G. Meacham and others.	8. Performing Organization Report No. ODOT- 3	9. Performing Organization Name and Address Ohio Department of Transportation 25 S. Front Street Columbus, Ohio 43215								
10. Work Unit No. (TRAIS)	11. Contract or Grant No. DOT-FH-11-8309	12. Sponsoring Agency Name and Address U.S. Offices of Research and Development Federal Highway Administration. U. S. Department of Transportation Washington, D. C. 20590								
13. Type of Report and Period Covered Final Report	14. Sponsoring Agency Code F0112	15. Supplementary Notes Prepared in cooperation with the Ohio State University, Columbus, Ohio. Additional authors: Dr. A.G.Bishara; Dr. S.Mitric; L.Besch,Jr.; J.O.Hurd; T.B.Culp; J.M.Golding; M.E.Smith.								
16. Abstract The study purpose is to identify various problems which are likely to arise during highway metrication and to prepare a detailed plan for research aimed at solving conversion problems. Investigations reveal a need for an early selection of the metric units to be used, the vital importance of early metrication of specifications and standards, and the absolute necessity of coordination of metrication activities on the national level. This volume contains appendixes to the material presented in Volume 1. These include a general bibliography, an annotated bibliography, lists of organizations contacted through written correspondence, summaries of interviews conducted by the research team, and selected plan pages for the Ohio Department of Transportation's Metric Project 3 (PER-188-3.84). This volume is the second in a series. The others in this series are: <table border="1"> <thead> <tr> <th>Vol.No.</th> <th>FHWA No.</th> <th>Short Title</th> <th>NTIS(PB)No.(if available)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>RD-75-68</td> <td>Tasks 1,2,3,4 and Apercu.</td> <td></td> </tr> </tbody> </table>			Vol.No.	FHWA No.	Short Title	NTIS(PB)No.(if available)	1	RD-75-68	Tasks 1,2,3,4 and Apercu.	
Vol.No.	FHWA No.	Short Title	NTIS(PB)No.(if available)							
1	RD-75-68	Tasks 1,2,3,4 and Apercu.								
17. Key Words Highway Metrication Metrication, Metric, S.I.	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151									
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 172								
		22. Price								

TABLE OF CONTENTS

<u>VOLUME 1</u>		PAGE
PREFACE		ii
ACKNOWLEDGMENTS		iv
INTRODUCTION		vii
TABLE OF CONTENTS		xi
TASK 1. Literature Review and Analysis		1
Chapter 1. Introduction		1
Chapter 2. Search for Information		2
Chapter 3. Review of Information Gathered		5
Section 3.1 Introduction		5
Section 3.2 Metric Units		5
Section 3.3 Metrication Methods		15
Section 3.4 Conversion Timetables		36
Section 3.5 Metrication of Standards and Specifications		62
Section 3.6 Metrication of Highway Materials		78
Section 3.7 Metrication of Highway Equipment		88
Section 3.8 Metric Training of Personnel		96
Section 3.9 Costs and Benefits of Highway Metrication		108
Section 3.10 Miscellaneous		120
TASK 2. Summarization of ODOT's Five Phase Work Program		126
Chapter 1. Introduction		126
Chapter 2. Phase 1: Design of Metric Highway Projects		127
Chapter 3. Phase 2: Construction of Metric Projects		156
Chapter 4. Phase 3: Public Use and Adaptation		185
Chapter 5. Phase 4: Public Information		215
Chapter 6. Phase 5: Public Reaction		221
Chapter 7. Evaluation of TASK 2		251
	ii	

	PAGE
TASK 3. Identification of Problem Areas	253
Chapter 1. Introduction	253
Chapter 2. National Aspects of Metrication	254
Chapter 3. State and Agency Organizations	263
Chapter 4. Planning, Location and Design	273
Chapter 5. Right-of-Way	286
Chapter 6. Construction	291
Chapter 7. Operations	301
Chapter 8. Conclusions	313
Chapter 9. Procedural Recommendations	318
 TASK 4. Program for Research	 323
Chapter 1. Introduction	323
Chapter 2. National Effort	324
Chapter 3. Metrication of the Transportation Industry	325
Chapter 4. Metrication of the Highway Mode	326
Chapter 5. Summary	336
 APERCU	 339

VOLUME 2

TABLE OF CONTENTS	ii
APPENDIXES	1
APPENDIX A - Sources of Information	2
Section 1. Libraries, Computer Searches and Other Metric Projects Contacted	3
Section 2. Organizations Contacted	6
Section 3. Highway Equipment Manufacturers Contacted	10
Section 4. Highway Material Manufacturers Contacted	15
Section 5. Letter from General Motors Corporation	17
Section 6. Reference Bibliography	19

	PAGE
APPENDIX B - Annotated Bibliography and Summaries of Interviews	29
Section 1. Annotated Bibliography on Highway Metrication	30
Section 2. Summaries of British Interviews	80
Section 3. Summaries of Other (Non-British) Interviews	87
APPENDIX C - A Comprehensive Bibliography of Metrication	130
APPENDIX D - Selected Plan Sheets from Metric Project No. 3 (PER-188-03.84)	156

APPENDIXES

- APPENDIX A. Sources of Information.
- APPENDIX B. Annotated Bibliography and Summaries of Interviews.
- APPENDIX C. A Comprehensive Bibliography of Metrication.
- APPENDIX D. Selected Plan Sheets from Metric Project No. 3 (PER-188-03.84).

APPENDIX A

Sources of Information

Section 1. Libraries, Computer Searches, and Other
Metric Projects Contacted.

Section 2. Organizations Contacted.

Section 3. Highway Equipment Manufacturers Contacted.

Section 4. Highway Materials Manufacturers Contacted.

Section 5. Letter from General Motors Corporation

Section 6. Reference Bibliography

Section 1. Libraries, Computer Searches and Other Metric
Projects Contacted

a. Libraries Contacted

	Sent some Material	Sent a Bibliography	Visited by the Research Team
Akron Public Library	x	x	x
Battelle Memorial Institute Library	x		x
Bowling Green State University Library	x	x	x
Case-Western Reserve University Libraries			
Cincinnati-Hamilton County Public Library			
Cleveland Public Library	x	x	x
The Cleveland State University Library	x		x
Columbus Public Library	x	x	x
Dayton and Montgomery County Public Library	x	x	x
Miami University Library			
Ohio State University Libraries			x
Ohio University Library			x
The Public Library of Youngstown and Mahoning County	x	x	x
The State Library of Ohio	x	x	x
Toledo-Lucas County Public Library	x	x	x
University of Akron Library			x
University of Cincinnati Library			
University of Dayton Library	x	x	x
University of Toledo Libraries			x
Wright-Patterson Technical Library			
Youngstown State University Library			x

b. Computer Searches

A,1

- (1) Mechanized Information Center (MIC)
The Ohio State University Libraries

Retrospective Services:

Multidisciplinary (MDS) under;
METRIC: all subtitles

Education (ERIC) under;
METRIC: all subtitles

Current Awareness Services:

Multidisciplinary (MDS) was sent to us on a
weekly basis. under;
METRIC: all subtitles

Social Sciences Information Service (SSIS) was
sent to us on a bi-weekly basis. under;
METRIC: all subtitles

- (2) Highway Research Information Service (HRIS)
Highway Research Board

On May 17, 1974 HRIS ran a BASIS 70 computer search
for our metric project.

- (3) Technical Information and Library on TRRL
Transport and Road Research Laboratory

On July 16, 1974 the TRRL ran a computer search for
our metric project entitled T12399 MH OHIO METRICATION.

c. Other Metric Projects Contacted

A,1

- (1) Fern E. Hunt
Department of Home Economics
The Ohio State University
Columbus, Ohio

Mrs. Hunt teaches the metric system to consumers and maintains current files on the literature. We were permitted to listen to her tape recordings of the Northeast Weights and Measures Association Convention held in Columbus, Ohio in the Spring of 1974.

- (2) Joel Magisos and Gloria Cooper
Metric Education
The Center for Vocational Education
The Ohio State University
Columbus, Ohio

The U.S. Office of Education recently awarded a three-year project concerning the "development and utilization of metric education instructional materials in vocational, technical, and adult education " to The Center. Mr. Richard Dieffenderfer, a project research member, has been working on the first major task which is preparing an annotated bibliography of metric education instructional and reference materials. He permitted our research team to review his literature collection.

- (3) John Wertz and Robert D. Mitchell
NSF-RANN Metric Conversion
University of Minnesota
Minneapolis, Minnesota

In 1973, the National Science Foundation, Research Applied to National Needs Division, awarded an 18 month project concerning "Conversion from the English to the Metric System in the United States" to the University. Mr. Mitchell provided our research team with some valuable bibliographic information and literature works.

Section 2. Organizations Contacted

Various companies, institutes, associations and governmental bodies (foreign and domestic) were contacted in an effort to learn their metric involvement and/or views on highway metrication. The addresses of these organizations may be obtained from the Federal Highway Administration.

a. Miscellaneous Organizations

- (1) American Concrete Institute
- (2) American Institute of Consulting Engineers
- (3) *American Iron and Steel Institute (AISI)
- (4) Mr. Marvin W. Stucky
Vice President
American Motors Corporation
- (5) Mr. Malcolm E. O'Hagan
Executive Director
American National Metric Council
- (6) American National Standards Institute, Inc. (ANSI)
- (7) American Road Builders Association
- (8) American Society for Engineering Education (ASEE)
- (9) American Society for Testing Materials
- (10) American Society of Civil Engineers (ASCE)
Metrication Committee
- (11)*American Society of Mechanical Engineers
- (12) The Asphalt Institute
- (13) The Associated General Contractors of America
- (14) Association Francaise de Normalisation

a. Miscellaneous Organizations (cont.)

- (15) Hans J. Milton
Director, Metric Conversion
Australian Department of Housing and Construction
- (16) The British Quarrying and Slag Federation, Ltd.
- (17) Mr. Kenyon
British Standards Institution
- (18) Professor Guy W. Richard, President
The Canadian Metric Association
- (19)* Director, The Commonwealth Railways
(Australia)
- (20) Kenneth Claxton, Assistant Secretary
Construction Industry Metric Change Liaison
RIBA Professional Services Dept.
(Great Britain)
- (21) Construction Industry Training Board
(Great Britain)
- (22) Consulting Engineers Council
- (23)* Chrysler Corporation
- (24)* Mr. M. J. Dolinsky, Chairman
Chief Planning Engineer
Department of Highways and Transport
(Alberta, Canada)
- (25)* Mr. J. M. Guthrie
Engineering Intelligence Division
Department of the Environment
(Great Britain)
- (26) Deutscher Normenausschuss
(Germany)
- (27) Mr. Harold K. Sperlich
Vice President
Ford Motor Company
- (28) General Motors Corporation

a. Miscellaneous Organizations (cont.)

- (29) International Standards Organization (ISO)
- (30)* Metrication Board
(Great Britain)
- (31) Metric Advisory Board
(New Zealand)
- (32) Mr. Louis F. Sokol, President
The Metric Association, Inc.
- (33) Metric Commission (Canada)
- (34) Chairman of Metric Conversion Board
(Australia)
- (35)* Japanese Industrial Standards Committee
Ministry of International Trade and Industry
- (36)* Mr. P. Smith, Director
Engineering Research Branch
Ministry of Transportation
(Canada)
- (37) Ministry of Transport
(Great Britain)
- (38)* Mr. R. J. Barling
Acting Assistant Secretary
Road Transport Branch
Ministry of Transport
(Australia)
- (39) R. P. Sleep
Assistant Chief Engineer
Engineering Intelligence Division
Ministry of Transport
(Great Britain)

Note: Reply to this letter was received from
J. M. Guthrie, Department of Environment

- (40) Transportation Research Board
National Academy of Sciences

a. Miscellaneous Organizations (cont.)

- (41) National Aeronautics and Space Administration
- (42) National Association of Australian Road Authorities
- (43)* National Constructors Association
- (44) National Society of Professional Engineers (NSPE)
- (45) Portland Cement Association
- (46)* Rovicpress, Ltd.
Metric Information Service
(Great Britain)
- (47) Society of Automotive Engineers
- (48) South African Bureau of Standards
- (49) Standards Association of Australia
- (50) Director
Transport and Road Research Laboratory
(Great Britain)
- (51)* Professor John M. Flowers,
Director, Project for Metric Research
Department of Science and Education
University of Southern Mississippi
- (52) Mr. Jeffrey V. Odom
Metric Information Office
U. S. Department of Commerce
National Bureau of Standards

*Asterisk indicates that no reply was received.

Section 3. Highway Equipment Manufacturers Contacted.

Eighty-four (84) companies were contacted in this endeavor. These companies are listed below, grouped according to their principal product. Addresses of these companies are available through the Federal Highway Administration. Thirty-seven (37) useful replies were received and catalogued as follows:

	<u>Yes</u>	<u>No</u>
Company has a metric officer and/or committee.	25	12
Company has a master plan.	22	15
Company is actively engaged in conversion.	26	11
•Dual Dimensioning	13	
•"Soft" Conversion	3	
•"Hard" Conversion	10	

a. Air Equipment

- (1) Ackley Manufacturing Co.
- (2) Chicago Pneumatic Equipment Co.
- (3) Gardner-Denver Co.
- (4) Ingersoll-Rand Co.
- (5) The Jaeger Machine Co.
- (6) Joy Manufacturing Co.
Air Power Group
- (7) *Kent Air Tool Co.
- (8) Quincy Compressor
- (9) Worthington-CEI, Inc.
Construction Equipment Division

b. Cranes, Backhoes and Graders

- (10) *American Hoist & Derrick Co.
(also make rollers)
- (11) *Bucyrus-Erie Co.

b. Cranes, Backhoes and Graders (cont.)

- (12) J. I. Case Company
Construction Equipment Div.
- (13) *Clark Equipment Co.
Austin-Western Div.
- (14) *Clark Equipment Co.
Construction Machinery Div.
- (15) *Deere & Company
- (16) *FMC Corporation
Crane & Excavator Div.
(also pile hammers)
- (17) *Ford Motor Company
Tractor & Implement Oper.--North Am.
- (18) Galion Manufacturing Co. (also rollers)
- (19) Harnishfeger Corporation
- (20) *International Harvester
Construction Equipment Div.
- (21) Liebherr-American, Inc.
- (22) *Manitowoc Engineering Co.
- (23) Massey-Ferguson Inc.

c. Crushing Plants

- (24) *Allis-Chalmers Manufacturing Co.
Crushing & Screening Equip. Div.
- (25) Eagle Crusher Co., Inc.
- (26) *Eagle Iron Works
- (27) *Iowa Manufacturing Co.

d. Earth Moving Equipment

- (28) *Caterpillar Tractor Co.
- (29) *Clark Equipment Co.
Hancock Division
- (30) *Fiat-Allis Construction Machinery, Inc.
- (31) *Komatsu America Corp.
- (32) *Terex Division
General Motors
- (33) *Wabco Construction & Mining Equip. Group
- (34) *White Construction Equipment

e. Pavers and Plants

- (35) *Barber-Greene Co.
- (36) Blaw-Knox Construction Equipment, Inc.
- (37) Boeing Construction Equipment Co.
- (38) Clark Equipment Co.
- (39) CMI Corporation
- (40) Curbmaster of America, Inc.
- (41) Erie Strayer Co.
Bucket Div. & Concrete Plant Div.
- (42) Gomaco Manufacturing Co.
- (43) Huron Manufacturing Corp.
- (44) Layton Manufacturing Co., Inc.
- (45) Maxon Corp.
- (46) Miller Formless Company, Inc.
- (47) *Power Curbers, Inc.

e. Pavers and Plants (cont.)

(48) *Rexnord, Inc.
Construction Machinery Div.

(49) *Seaman Co.

f. Pumps (Water and Concrete)

(50) *The Gorman Rupp Co.

(51) *Morgen Manufacturing Co.
(concrete conveyor systems)

(52) Wilden Pump & Engineering Co.

g. Rollers

(53) Dynapac Manufacturers, Inc.

(54) *Hyster Co.
Construction Equipment Div.

(55) *RayGo, Inc.

(56) Resco Manufacturing Co.

(57) Tampo Manufacturing Co.

h. Scales

(58) Thurman Scale Co.

i. Surveying Equipment

(59) Hewlett-Packard Co.
Civil Engineering Div.

(60) *Keuffel & Esser Co.

(61) *The Lietz Co.

(62) *Wild Heerbrugg Instruments, Inc.

j. Tools

(63) The Black & Decker Mfg. Co.

j. Tools (cont.)

A,3

- (64) Homelite
- (65) Stanley Hydraulic Tools
- (66) *Wacker Corporation
- (67) The Wyco Tool Co.

k. Trucks

- (68) Chevrolet Motor Division
- (69) Diamond Reo Trucks, Inc.
- (70) Euclid, Inc.
- (71) Ford Truck Division
- (72) FWD Corporation
- (73) *International Harvester Co.
Truck Division
- (74) *Mack Trucks, Inc.
- (75) Oshkosh Truck Corp.
- (76) White Trucks

l. Welding Machines

- (77) *Hobart Brothers Co.
- (78) The Lincoln Electric Co.
- (79) Miller Electric Manufacturing Co.

m. Miscellaneous

- (80) Charles Machine Works, Inc.
(makers of trenching equip.)
- (81) Delmag Maschinenfabrik
(pile hammers)

m. Miscellaneous (cont.)

- (82) *R. E. Dietz
(safety equipment)
- (83) *Soiltest, Inc.
(testing equipment)
- (84) Speed Shore Corp.
(shoring for trenches)

*Asterisk indicates that a reply was received.

Section 4. Highway Material Manufacturers Contacted

Twenty (20) companies were contacted in this endeavor. Addresses of these companies are available through the Federal Highway Administration. Ten (10) useful replies were received and catalogued as follows:

	<u>Yes</u>	<u>No</u>
Company has a metric officer and/or committee.	6	4
Company has a master plan.	3	7
Company is actively engaged in conversion	5	5
•Dual dimensioning	1	
•"Soft" Conversion	2	
•"Hard" Conversion	2	

Companies Contacted Were:

- (1) *American Aggregates Corp.
- (2) Armco Steel Corp.
Metal Products Div.
- (3) *Bethlehem Steel Corp.
- (4) *The Dow Chemical Co.
Functional Products & Systems
(mortars, cements, explosives)
- (5) *Exxon Company, U.S.A.
(asphalt, fuels, joint mat'l)

- (6) *General Tire & Rubber Co.
(bearing pads, joint seals)
- (7) Hercules Inc.
(explosives)
- (8) Jones & Laughlin Steel Corp.
Wire Rope Division
- (9) *3 M Company
(caulking comp., paints, waterproofing)
- (10) Martin Marietta Corp.
(cement, grouts, admixtures)
- (11) Master Builders
(admixtures)
- (12) Medusa Cement Co.
(cements)
- (13) Mobil Oil Corp.
North American Division
(fuels, asphalt)
- (14) *Neenah Foundary Co.
(castings)
- (15) *Republic Steel Corp.
Manufacturing Div.
- (16) *Superior Products Company
(concrete pipe)
- (17) *Texaco, Inc.
(asphalt)
- (18) Union Metal Manufacturing Co.
(light poles)
- (19) *United States Steel Corp.
- (20) U. S. Plywood
(plywood, forms, adhesives, water repellents,
lumber)

*Asterisk indicates that a reply was received.

Section 5. Letter from General Motors Corporation A,5

A, 5, 1 Letter to ODOT/OSU Metric Research team from
Everett L. Baugh, General Motors Corporation.

As you probably know, General Motors is changing to the metric system at a rate tied to the release of new assemblies and products. This approach is designed to accomplish metrification over a number of years at negligible cost. A copy of the Public Relations release which describes this is enclosed (See Below).

We are not involved in highway metrification except at our proving grounds. Whatever needs to be done, which isn't much, is tied into normal obsolescence and modernization plans. If this is done carefully metrification costs are so small they get lost. For instance, what is the life of a good sign? If it is replaced at the normal time with a metric or dually-dimensioned sign, how much did the metric system contribute to the costs? The effect of specification on highway contractors is beyond our scope of knowledge.

The speedometers on most General Motors cars in the United States, starting with the 1975 models will indicate speed in both miles per hour and kilometres per hour. However, introduction of dual reading odometers would be more complex and expensive. Present plans are to show miles only.

There are a number of regulations and laws which require measurement of the car's accumulation of miles. The state and federal governments have quite a bit to do before a change to kilometres exclusively would be legal.

If conversion plans would include at least 10 years of dually-dimensioned road signs, there should be little need for conversion of old speedometers. Most of them, like old soldiers, would fade away.

News Release

DETROIT -- In keeping with the long-term movement toward more general use of the metric system, here and abroad, General Motors President Edward N. Cole stated that "the rate of implementation to the metric system within GM will be governed by the release of new parts, metrically dimensioned, and by the normal phasing out of in-production parts."

The GM guidelines include:

1. New developments will be metric from the start. This includes items now in development stage.
2. Service parts now in production will remain as is.
3. Supplier coordination will be implemented as required.
4. In the interim before complete metrication is accomplished some capital equipment with dual measuring capability will be required.

Coordination of the entire program will be handled by the GM Engineering Staff.

Section 6. Reference Bibliography

The following is a list of general references and bibliographies that have been used in the literature search. Annual editions were searched from 1960 to the present where possible.

American Library Resources: A Bibliographic Guide,
Downs, R. B., American Library Association,
Chicago, 1972.

Annotated Bibliography of Scientific Research in Road
Traffic and Safety, Haight, R. A.,
University of California, Institute of Transportation
and Traffic Engineering, Berkeley, 1963.

Applied Science and Technology Index,
Toom, E., ed., The H. W. Wilson, Co.,
New York, 1913--.

Basic Traffic Engineering References,
Institute of Traffic Engineers,
Washington, D. C., 1965.

Bibliographic Index: A Cumulative Bibliography of
Bibliographies, Case, A. M., Franck, M., ed.,
The H. W. Wilson Co., New York, 1937--.

Bibliography of the Metric System,
Antoine, V., Milek, J. T., The Metric Association, Inc.,
Waukegan, Ill., 1968.

Bibliography of Traffic Engineering,
Duff, J. T., Printerhall, Ltd., London, 1966.

A Brief Guide to Sources of Scientific and Technical
Information, Herner, S., Information Resources Press,
Washington, D. C., 1970.

British Museum General Catalogue of Printed Books,
Trustees of the British Museum, London, 1959-66,
Supplements, 1968, 1971-72.

The British National Bibliography,
Wells, A. J., ed., Council of the British National
Bibliography, Ltd., London, 1950--.

British Technology Index, Coates, E. J., ed.,
The Library Association, London, 1962--.

Business Periodicals Index, Third, B. J., ed.,
The H. W. Wilson Co., New York, 1956--.

Changing to the Metric System, Anderton, P.,
Bigg, P. H., Her Majesty's Stationery Office,
London, 1969, pp. 32-33.

Classed Subject Catalog of the Engineering Societies
Library, G. K. Hall & Co., Boston, 1963, Supplements,
1964--.

Conversion to Metric System of Measurement,
Grebneff, A., State Library of South Australia,
Adelaide, 1970.

Current Literature in Traffic and Transportation,
Transportation Center at Northwestern University,
Evanston, Ill., 1960--.

"Decimalization and Metrication," Advancement of Science,
Vol. 26, March, 1970, pp. 240-242. (London)

Directory of Computerized Information in Science and
Technology, Cohan, L., ed., Science Associates/
International, Inc., New York, 1968.

Dissertation Abstracts International,
University Microfilms, Ann Arbor, Mich., 1938--.

Engineering Index, Engineering Index, Inc., New York, 1884--.

Finding and Using Technical Information, Carey, R. J. P., Edward Arnold, Ltd., London, 1966.

Freeway Operations Bibliography 1964-68, Highway Research Board, Washington, D. C., 1969.

A Guide to a Selection of Computer-Based Science and Technology Reference Services in the U. S. A., Science and Technology Reference Services Committee, American Library Association, Chicago, 1969.

Guide to Literature on Transportation Engineering, Hickok, B., American Society for Engineering Education, Washington, D. C., 1970.

A Guide to Metrication, Jones, M. J. B., Pergamon Press, Ltd., London, 1969, pp. 136-139.

Guide to Reference Books, Winchell, C., 8th ed., American Library Association, Chicago, 1967, Supplements 1965--.

Guide to Reference Material, Walford, A. J., ed., 3rd ed., Vol. 1, The Library Association, London, 1973.

Hand List of Short Titles of Current Periodicals in the Science Museum Library, Phippen, H. D., London Science Museum Library, London, 1965.

Highways--Current Literature, United States Department of Transportation, Washington, D. C., 1922--.

Highway Research Abstracts, Highway Research Board, Washington, D. C., 1931--.

Highway Research in Progress, Highway Research Board,
Washington, D. C., 1965--.

Information on the Metric System and Related Fields,
Lange, E., 6th ed., NASA/Marshall Space Flight Center,
Alabama, 1974.

Library Acquisitions and Services, United States
Department of Transportation Library Services
Division, Washington, D. C., 1970--.

Library Guiding; A Program for Exploiting
Library Resources, Carey, R. J. P., Linnet Books,
Hamden, Conn., 1974.

Library of Congress Catalog--Books: Subjects,
The Library of Congress, J. W. Edwards, Inc.,
Ann Arbor, Mich., 1950--.

List of Current Publications, National Association
of Australian State Road Authorities, Sydney,
Australia, 1974.

List of Serial Publications in the British Museum
Library, Trustees of the British Museum, London, 1968.

Metricated Books, Jackson, P. F., 2nd ed.,
The Library Association, London, 1971.

Metrication: A Bibliography, Atkins, J. L., ed.,
CADIG Liaison Center, Reference Library,
Coventry, England, 1968.

Metrication: A Bibliography to 30th June, 1968,
Field, H., Building Design Partnership,
London, 1968.

Metrication--Decimalisation: A Bibliography,
Coventry City Libraries, Coventry, England, 1967.

Metrication the Coming Event, Markuson, C., Watchung Hills Regional High School, Warren, N. J., 1973.

A Metric America; A Decision Whose Time Has Come, DeSimone, D. V., National Bureau of Standards, Washington, D. C., 1971, pp. 164-166.

Metric Bibliography: A Selection of the More Important Material of Interest to the Construction Industry, 6th ed., Department of the Environment, London, 1972.

Metric Conversion Bills, American Enterprise Institute for Public Policy Research, Washington, D. C., pp. 23-34.

British Standards for Engineering, British Standards Institution, London, 1966.

Mettrins: A Guide to Metrication Information and Sources, London Barough of Lewisham, Technical Reference Library, London, 1971.

Monthly Catalog of United States Government Publications, United States Government Printing Office, Washington, D.C., 1895--.

The National Union Catalog, A Cumulative Author List, American Library Association, Library of Congress, Washington, D. C., 1953/57--.

The National Union Catalog, Pre-1956 Imprints, American Library Association, Mansell Information/Publishing, Ltd., London, 1974.

Publication Index, Jackson, E. W., ed., Highway Research Board, Washington, D. C., 1921--.

Public Affairs Information Service, Wilson, R. S., ed., Public Affairs Information Service, Inc., New York, 1915--.

Reader's Guide to Periodical Literature, Limerick, Z., ed.,
The H. W. Wilson Co., New York, 1890--.

Records and Research in Engineering and Industrial Science,
Helmstrom, J. E., 3rd ed., Chapman & Hall, Ltd., London,
1956.

A Reference Guide to Metropolitan Transportation; An
Annotated Bibliography, Library of the Transportation
Center, Northwestern University Press, Evanston, Ill., 1964.

Research in Transportation: Legal/Legislative and Economic
Sources and Procedure, Flood, K. U., Gale Research Co.,
Detroit, Mich., 1970.

Road Abstracts, Road Research Laboratory, Her Majesty's
Stationery Office, London, 1934--.

"SAF Looks at Metrication," Journal of Forestry,
Vol. 69, No. 4, April, 1971, p. 223.

Science and Engineering Reference Sources: A Guide for
Students and Librarians, Malinowsky, H. R., Libraries
Unlimited, Inc., Rochester, N. Y., 1967.

Science and Technology; An Introduction to the Literature,
Grogan, D. J., 2nd ed., Clive Bingley, Ltd., London, 1973.

A Selected and Annotated Survey of the Literature On
Transportation; Status, Structure, Characteristics,
Problems, and Proposed Solutions, Grauman, J., et al.,
The Franklin Institute Research Laboratories Science
Information Services, Philadelphia, 1968.

Selected References on Traffic Engineering, University of
California, Institute of Transportation and Traffic
Engineering, Berkeley, 1965.

SI Units in Engineering, Blackman, D. R.,
Macmillan, London, 1969.

Social Sciences and Humanities Index, Dart, J. D., ed.,
The H. W. Wilson Co., New York, 1907--.

Some References on Metric Information,
National Bureau of Standards, Washington, D. C., 1973.

Sources of Engineering Information, Dalton, B. H.,
University of California Press, Berkeley, 1948.

Sources of Information in Transportation, Blaisdell, R. F.,
et al., Transportation Center at Northwestern University,
Evanston, Ill., 1964.

Subject Catalog of the Department Library, Department of
Health, Education, and Welfare Library, G. K. Hall & Co.,
Boston, 1965.

Technical Book Review Index, Special Libraries Association,
New York, 1935--.

Transportation Information Sources, Metcalf, K. N.,
Gale Research Co., Detroit, Mich., 1965.

Transportation in Canada and the United States:
A Bibliography of Selected References 1945-1967,
Tangri, O. P., University of Manitoba, Winnipeg, 1968.

Union List of Serials in Libraries of the United States
and Canada, Titus, E. B., ed., 3rd ed., The H. W. Wilson Co.,
New York, 1965.

The United States and the Metric System, Holt, S. F.,
Federal Reserve Bank of Minneapolis, Minneapolis, Minn.,
1972, pp. 34-35.

U. S. Metric Study Interim Report, DeSimone, D. V., Vol. 6,
National Bureau of Standards, Washington, D. C., 1971.
pp. 200-201.

U.S. Metric Study Interim Report, DeSimone, D. V., Vol. 10, National Bureau of Standards, Washington, D. C., 1971.

A World Bibliography of Bibliographies, Berterman, T., 4th ed., Lausanne, Switzerland, 1965-66.

1970 World Survey of Current Research and Development on Roads and Road Transport, United States Department of Transportation, Washington, D. C., 1970.

Annotated Bibliography on the Metric System, Hines, R., Tennessee Research Coordinating Unit, Knoxville, Tennessee, 1974.

A Bibliography of Metric Standards, American National Standards Institute, Inc., New York, 1974.

Canadian Theses, Lunn, J., ed., National Library of Canada, Ottawa, 1964--.

Guide to Lists of Master's Theses, Black, D. M., American Library Association, 1965.

"Information Sources on Metrication -- A Selective List," Peck, T. P., Special Libraries, Vol. 64, No. 7, July, 1973, pp. 291-296.

Index to Theses Accepted for Higher Degrees by the Universities of Great Britain and Ireland and the Council for National Academic Awards, Hardy, J. E. , Paterson, G. M., Whitrow, M., Aslib, London, 1962--.

Libraries in the United Kingdom and the Republic of Ireland, 4th ed., The Library Association, London, 1971.

The Libraries of London, Irwin, R., Staveley, R., ed., 2nd ed., The Library Association, London, 1961.

List of Australian Metric Standards, The Standards Association of Australia, Sydney, Australia, 1974.

"Metrication," Walley, F., Institution of Civil Engineers Proceedings, London, Vol. 40, May, 1968, p. 124.

Metrication Bibliography -- Books and Pamphlets, Department of Trade and Industry, London, 1972.

Metric Booklist, Metrication Board, London, 1972.

Metric Memo -- Training Aids, Metrication Board, London, 1972.

Metric Standards Published and in Progress, 3rd ed., The British Standards Institution, London, 1969.

Metric Standards Published and in Progress, 3rd. ed., supplement no. 1, The British Standards Institution, London, 1970.

Metric System -- Selected References, Highway Research Information Service, Highway Research Board Library, Washington, D.C., 1973.

The Millimeters are Coming, Gilleland, G., Kansas City Public Library, Kansas City, Missouri, 1973.

Publications for the Building Industry, Metric Conversion Board, St. Leonards, Australia, 1974.

"Reading References on the Metric System and Related Fields," American Metric Journal, Vol. 1, No. 1, September, 1973, p. 26.

"Reading References on the Metric System and Related Fields," American Metric Journal, Vol. 1, No. 2, November, 1973, p. 45.

Selective Bibliography, Fairweather, L., Sliwa, J. A., The Architectural Press, London, 1970, pp. 185-190.

Special Library and Information Services in the United Kingdom, Burkett, J., ed., 2nd ed., The Library Association, London, 1965.

Union List of Higher Degree Theses in Australian University Libraries, Wylie, E., University of Tasmania Library, Hobart, Australia, 1967.

Union List of Higher Degree Theses of the Universities of New Zealand, Swift, C. G., 1963-1967 supplement, New Zealand Library Association, Wellington, New Zealand, 1969.

APPENDIX B

Annotated Bibliography and Summaries of Interviews

Section 1. Annotated Bibliography on Highway Metrication.

All material used in the analysis of literature appears in this bibliography. Following each bibliographical entry is a very short abstract of the work. This abstract is intended to give the reader an idea of the contents of the work. In some cases, a special effort is made to draw the reader's attention to the contents of the work which are relevant to the field of highway engineering.

Section 2. Summaries of British Interviews

Brief summaries of the seventeen interviews held with various British public and private agencies.

Section 3. Summaries of other (Non-British) Interviews

Summaries of interviews held with personnel involved in the design of Metric Project No. 3 (PER-188-03.84).

Section 1. Annotated Bibliography on Highway Metrication^{B,1}

B, 1, 1

"A.R.C. Reinforcement Data Sheet," A.R.C. Engineering Pty.
Ltd., Australia, Dec., 1973.

Relevant properties of all Reinforcement sold by A.R.C. are given in metric units. Tables show comparisons between imperial and metric products. Metric replacements of imperial products are given.

B, 1, 2

Adams, H.F.R., SI Metric Units: An Introduction, McGraw
Hill Ryerson Limited, Toronto, 1973.

The first thirteen chapters of this book deal with the history of and rules for use of the SI. The following chapters each describe how to make calculations in the SI for particular purposes; each of these chapters finish with a group of problems to test the reader's knowledge. Some of the answers in the back are wrong, however. Appendices contain conversion tables.

B, 1, 3

"The Adoption of the Metric System in Engineering: Basic Programme and Guide," PD6424, British Standards Institution, London, July, 1968.

Background information is given discussing how Britain plans to adopt the SI. General guidelines for changing an engineering firm to SI units are given. Also, the national program for the metrication of engineering is presented.

B, 1, 4

"Aggregate," Metric Change Information Sheet, Metric Conversion Board, Oct. 26, 1972.

This publication gives conversion dates, new units to be used, new sizes and references for further information for both sand and aggregate.

B, 1, 5

"Australian Made Metric Cars Now Being Planned," MCB Newsletter, Vol. 3, No. 6, April, 1974, p. 1.

Leyland, an Australian Automobile manufacturer, has decided to "go metric." Their plans for dealing with metrication problems are discussed in this article.

B, 1, 6

Au-Yeung, Y., "Design Charts for Reinforced Concrete Beams in Metric Units," Civil Engineering, Vol. 38, No. 5, May, 1968, pp. 56-57.

The author illustrates two charts. The first one determines the minimum effective depth required in a given concrete beam. The other one determines the minimum effective area of the reinforcing steel. The author uses "common" metric stress units, e.g. kg/cm^2 . An example problem using the charts is given.

B, 1, 7

Baker, J.B., "How to Adapt the Metric System," Iron Age, Vol. 190, No. 9, Aug. 30, 1962, pp. 121-123.

The author gives helpful hints to the person who wants to change his business to the metric system. Included in his discussions are: the establishment of a metrication

B, 1, 7 (cont.)

B,1

chief, drawing practice, tools, machine replacement, materials, foreign demand and cost estimates.

B, 1, 8

Barr, A.W.C., "The Public Sector," presented at a Metrication Board Conference on Building and Civil Engineering, London, July, 1971.

The public sector, which accounts for over half of Britain's construction work, is over 60% metric. The author discusses the construction industry's conversion program, dimensional coordination, metrication in various ministries, progress, experience, cost, availability of components and future programs.

B, 1, 9

Binney, H.A.R., "Metrication for the Unites States -- How Britain is Doing It," Mechanical Engineering, Vol. 91, No. 5, May 1969, pp. 16-18.

Binney discusses the history of Britain's metrication decision, the British metrication program for engineering, international standardization, and the benefits vs. the cost of metrication.

B, 1, 10

Bourne, C.R., "The Problems of Conversion of Maps and Plans to the Metric System," presented at the Conference of Commonwealth Survey Officers, Paper No. 41, Tech. Paper No. 13, 1963.

The problems of the possible metrication of maps, plans and related publications are discussed with emphasis on the problems of scale and contour interval conversions. The time is considered opportune for the change since the Ordnance Survey has begun a new program recently. Costs and Benefits are also discussed.

B, 1, 11

Burgess, J.W., "The Impact of Metrication on Design Engineering and Construction," Chemical Engineering Progress, Vol. 68, No. 6, June 1972, pp. 69-70.

Engineering firms must supply customers with design data in the most efficient way possible. Therefore, whatever system of units is most convenient will be adopted. Since the author believes the SI system is too cumbersome, he concludes that the "common" metric units, e.g. the kilogram-force, will be adopted.

B, 1, 12

Calder, Ritchie P., "British Experience in Converting to Metric," SAE Journal, Vol. 78, No. 10, Oct., 1970, pp.31-33.

The author outlines Britain's metrication program, stressing the fact that vast problems do not seem insurmountable when broken into their components. Rationalization standards and government intervention are discussed.

B, 1, 13

"Canada Prepares for Metric Conversion," Bank of Montreal Business Review, Jan., 1974, pp. 1-4.

A description of the SI is given along with a short history of weights and measures. The Canadian metrication program is described and the organization of their metric commission is outlined. The mistakes made by Britain in their metrication program are mentioned. A short table at the end gives metric/imperial conversions.

B, 1, 14

"Cement," Metric Change Information Sheet, Oct. 19, 1972,
p. 1.

Information on the metrication of cement is listed as follows: conversion date, units and sizes used, relevant metricated Australian standards and references for further information. The same information is given for sand.

B, 1, 15

"The Change to Metric and Its Implications," Road
Engineering Industry Standards Committee of the
British Standards Institution, London, Jan. 1, 1969.

Proposals are made concerning the timing of metrication in the Road Engineering Industry. Rules for using metric units, metrication of specifications, plans, drawings, surveys and laboratory operations are discussed. Training techniques are presented.

B, 1, 16

"Change to Metric in Commercial Road Transport," Metric
Advisory Board, Wellington, New Zealand, Feb. 22, 1973.

Covered in this document are the metric conversion time table for commercial road transport, publicity and

B, 1, 16 (cont.)

B,1

information, costs, units to be used, speedometers, retraining and freight rates.

B, 1, 17

"Change to Metric in Road Transport," Metric Advisory Board, Wellington, New Zealand, Nov. 1, 1972.

This pamphlet discusses the metrication programme, timing for the change, the costs involved, speedometers and metrication aids. A time bar chart is included.

B, 1, 18

"Change to Metric; What it Means to the British Construction Industry," American Concrete Institute Journal, Vol. 65, supp. 10+, Oct. 1968.

The article discusses the following problems of metric conversion: rationalization of dimensions, product availability, increase in errors, retraining, dimensional tolerances and interchangeability. Each problem is discussed with emphasis on how it applies to the construction industry.

B, 1, 19

Change to the Metric System in the United Kingdom, Her Majesty's Stationery Office, London, 1968

This general and short work sketches Britain's progress in metrication and their outlook for the future metrication activities. There are no direct references to highways.

B, 1, 20

B,1

"Change to the Metric System; Programme for Equipment Required by the Members of the E.E.U.A.," EEUA Document No. 33D, Engineering Equipment Users Association, London, 1967.

Charts show conversion timetables for equipment used and general practices in the areas of design, drafting, workshop practice, civil engineering, mechanical engineering, electrical engineering, control and instrumentation engineering and other materials. An explanation accompanies the charts.

B, 1, 21

"Clay Bricks," Metric Change Information Sheet, Metric Conversion Board, Oct. 19, 1972, p. 1.

Given are, conversion dates, units to be used, new sizes and tolerances, a list of relevant metricated Australian standards and references for further information.

B, 1, 22

"Commercial Weights and Measures," U.S. Metric Study Interim Report, Vol. 3, U.S. Department of Commerce, Washington, D.C., July, 1971.

The problems of metrication as it affects commercial enterprises and consumers are discussed. Some comments are given, along with a suggested program, on educating personnel.

B, 1, 23

"Concrete Pipes," Metric Change Information Sheet, Metric Conversion Board, July 20, 1973, p. 1.

B, 1, 23 (cont.)

Conversion dates, new units, relevant metricated Australian standards, changes in designation practice and new sizes are given.

B, 1, 24

"Construction of Flexibly Jointed Concrete Pipelines,"
Technical Bulletin No. 1, The Concrete Pipe Association
of Great Britain, Brenchly, England, 1974.

All the procedures used in laying concrete pipe, from site preparation to acceptance tests are given in this manual. Imperial-metric conversions are listed as are the approximate metric weights of concrete pipes.

B, 1, 25

"Correct SI Measuring Instruments," MPT6a, South African
Bureau of Standards, Oct., 1972.

This pamphlet describes those metric measuring instruments sanctioned by the South African Bureau of Standards. Illustrations are shown.

B, 1, 26

Cruickshank, H.J., "Metrication: Coming to the Point,"
Civil Engineering Public Works Review, Vol. 66, April,
1971, pp. 431-432.

The article elucidates Britain's time table for metric conversion and discusses the differences between civil engineering metrication problems and building industry metrication problems.

B, 1, 27

Crutchley, G.I., "Thoughts on Metrication: Design and Construction of a Regional Sewerage and Sewage Disposal Scheme," Civil Engineering and Public Works Review, April, 1971, p. 433.

The author describes the operations carried out in building a new sewage disposal system in metric units. Included in his discussions are design, drafting, tendering and construction.

B, 1, 28

"Data Sheet: Hot Rolled Reinforcing Bars," GKN Limited, South Wales, date unknown.

This sheet gives the following metric data on reinforcing bars: Metric areas, metric areas per meter, metric areas per foot, metric weights, metric weights per sq. meter and dimensions of deformed bars.

B, 1, 29

Davies, Colin, "Composite Beam Design Charts in SI Units," Civil Engineering and Public Works Review, Vol. 67, No. 787, Feb., 1972, pp. 145-52.

This article is a metricated version of the original which appeared in Vol. 62, pp. 533-7 and 685-90 of the same journal. The article describes an algorithm, by use of charts, to select steel beam sizes for steel-concrete composite, unhaunched beams.

B, 1, 30

"Decimalisation and Metrication -- How and when in Premix," Premix Concrete Limited, Oxford, England, June, 1970.

This publication is a guide for consumers of premix concrete. Tables of equivalents for decimal and non-decimal currency, price per yd^3 and price per m^3 , inches and millimeters, psi and newtons per mm^2 , and others are given along with explanations. Timetables and conversion philosophies for concrete manufacture and supply are given.

B, 1, 31

Desimone, D.V., "Metric Engineering Standards,"
Reprographics, Vol. 10, No. 1, 1972, p. 25.

The author first outlines what engineering standards are and why they are necessary. He then presents an analysis of a general nature concerning the ways in which the British converted their engineering standards to the metric system.

B, 1, 32

Diamant, Rudolph Maximilian Eugene, Understanding SI
Metrication, Angus and Robertson, London, 1970.

The author gives background material on SI units such as history, rules for usage, and reasons for going to metric. Applications in the fields of power engineering, physics, electronics, manufacturing, construction and everyday life are discussed. Conversion tables are included.

B, 1, 33

Dodd, J.M., "Problems and Possible Effects of Change to the Metric System," Municipal Engineer, Vol. 145, No. 19, May 10, 1968, pp. 910-913.

The author discusses dimensional tolerances in municipal

B, 1, 33 (cont.)

B,1

engineering projects. Also discussed are ordinance survey scales.

B, 1, 34

Donovan, Frank, Prepare Now for a Metric Future, Weybright and Talley, New York, 1970.

This is a popularly oriented book which gives little information of value to technical and professional persons. There is one paragraph discussing highway road signs, however.

B, 1, 35

"Drill Sizes for ISO Metric Coarse Thread Series -- General Purposes," Metric Change Information Sheet, Feb. 27, 1974, pp. 1-2.

This publication states when imperial drills will be phased out, gives metric drill sizes for use in conjunction with metric thread fasteners, lists metricated Australian Drill Standards, and gives metric equivalents of imperial drill sizes.

B, 1, 36

Dunstone, Phillip, "Quantity Surveying," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.

The ways and means of converting quantity surveying to metric units is presented. Topics for discussion include new equipment, consultation materials, costs, training, overcoming difficulties and impediments to the change.

B, 1, 37

"E.E.U.A. Metrication Situation Report," E.E.U.A. Document No. 40D, Engineering Equipment Users Association, London, 1971.

This document lists a table for each of many categories of equipment, components and raw materials. This table gives information as to the metric availability of each standard which applies in the given category. Updating ammendments are issued periodically.

B, 1, 38

Ede, A.J., Advantages of the Metric System, HMSO, London, 1972.

This book discusses the background of the SI system and then proceeds to explain its advantages in everyday use, technical use and specialized use.

B, 1, 39

Edwards, P.B., "Structural Engineering," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.

The author discusses the effects of metrication on structural engineering. Included in the discussion are changes in specifications, changes in drawings, dimensional coordination, rationalization, time tables and past experience.

B, 1, 40

Fairweather, L. and Sliwa, J., AJ Metric Handbook, 3rd ed., Architectural Press, London, 1970.

Everything the architect needs to know about the metric

system and metrication is presented in this manual. Design data for everything from bicycle racks to office buildings are given in metric. Conversion tables are given. Many design problems are worked in the SI, the metric technical system and the imperial system, side by side.

B, 1, 41

Falkner, Leon W., et.al., "The Main Battle Tank -- A Factual Experience in Metrics," SAE Journal, Vol. 79, No. 9, Sept. 1971, pp. 73-9.

The author describes the joint German-American effort to produce the Main Battle Tank. Difficulties in resolving metric/imperial conflicts are discussed. General conclusions about metrication are offered.

B, 1, 42

"Federal Government: Civilian Agencies," U.S. Metric Study Interim Report, Vol. 2, U.S. Department of Commerce, Washington, D.C., Aug. 1971.

The FHWA and other transportation organizations provide some comments on metrication. Other organizations, not related to highways, also comment.

B, 1, 43

"First Report on the Metric Changeover Timetable for the Engineering and Engineering Servicing Industries," Metric Advisory Board, Wellington, New Zealand, June 23, 1972.

This report reviews the timetable for metrication in engineering including design, drafting, standards, tools,

B, 1, 43 (cont.)

fasteners, materials, training and publicity. Plans for the future are given.

B, 1, 44

"Following Standard Rules Eases Metric/Inch Dual Dimensioning," SAE Journal of Automotive Engineering, Vol. 78, No. 11, Nov., 1970, pp. 32-3.

A description of the rules to follow when putting dual dimensions on a drawing is given. Problems discussed include forms of representation and tolerances. The article is a synopsis of rules presented in SAE J 390, Dual Dimensioning.

B, 1, 45

Friesth, E.R., "Metrication in the Off Road Vehicle Industry," American Metric Journal, Vol. 1, No. 1, Sept. 1973, pp. 16-19.

The author provides the information gathered by a metric study group in the John Deere Company. Metric conversion problems in the following areas are discussed: drawings, unit application, retraining, machine tools and engineering standards.

B, 1, 46

Going Metric -- Engineering Progress and Future Programs, Conference Report, Metrication Board, 1971.

The report consists of a collection of papers presented at the conference. Each paper has as its topic an engineering product or service and describes manufacturing, or user, or stockholding aspects of the metrication of the product or

service. Products discussed include aluminum, steel, tools, belts, gears, fasteners, measuring equipment, pipes, etc. Services include consulting and designing.

B, 1, 47

"Going Metric: First Stages," PD 6245, The British Standards Institution, London, Aug. 1967.

This report discusses the background to the decision for metrication and the progress made in the first two years. Problems of metrication of standards, the coordination of the change, the timing of metrication in the construction industry, and the role of the government are all discussed. The report mentions the SI units will be adopted, in preference to other metric systems.

B, 1, 48

"Going Metric in the Construction Industry," Great Britain Ministry of Public Building and Works, London, 1971.

This publication is separated into three volumes. The first deals with the reasons for the change, the history of the metric system, the units of measurement and the programme adopted for change. The second describes the general theory and application of dimensional coordination for designers, manufacturers and contractors. The last volume gives guidance and practical examples on the method of locating components and assemblies.

B, 1, 49

Going Metric -- Looking Ahead, Metrication Board, London, 1972.

This is the third of the annual reports of the Metrication Board. It is a complete report on the status of Britain's metrication program in 1972. Plans for the future are presented. There is one chapter on transportation and communications.

B, 1, 50

Going Metric: Progress in 1970, The Metrication Board, HMSO, London, 1971.

This is the second annual report of the Metrication Board. See Going Metric -- the First Five Years -- 1965-1969, for the annotation.

B, 1, 51

Going Metric: Progress in 1972, The Metrication Board, HMSO, London, 1973.

This is the fourth annual report of the Metrication Board. See Going Metric -- the First Five Years -- 1965-1969 for the annotation.

B, 1, 52

"Going Metric: Retraining Design Staff," Metrication Board, London, date unknown.

Very general guidelines are given to the company that must retrain design staff.

B, 1, 53

Going Metric -- The First Five Years -- 1965-1969,

Metrication Board, London, 1970.

This is the first of the annual reports of the Metrication Board. It is a complete report on the status of Britain's metrication programme in 1970. Plans for the future are presented. There is one chapter on transportation and communications.

B, 1, 54

Going Metric: The Next Phase, The Metrication Board, HMSO, London, 1974.

The fifth annual report of the Metrication Board. See Going Metric -- The First Five Years -- 1965-1969 for annotation.

B, 1, 55

Green, Victor E., "A Plea to Stop the Use of the Quintal as a Metric Weight Measure," Soil Science Society of America Proceedings, Vol. 33, No. 6, 1969, pp. 978-9.

The author uses examples to show how varied the definition of the quintal is throughout the world. Since the unit is not standard, the author believes it should not be used.

B, 1, 56

"A Guide for the Use of the Metric System in the Construction Industry," 2nd ed., PD 6031, British Standards Institution, London, Dec. 1968.

SI units are identified and described. Rules for presenting numerical data are given -- including a

B, 1, 56 (cont.)

B,1

recommendation to use the raised period for a decimal marker. Drawings and scales are discussed. The Appendix lists conversion factors and tables of units for general civil engineering, for structures and for roads and highways.

B, 1, 57

"Guide to all CITB Metrication Re-training Aids,"
Construction Industry Training Board, London, June,
1973.

This is a small pamphlet which gives some general comments on the formulation of a metrication re-training program. Following the comments is a flow chart of precisely how and when to use CITB Re-training aids in such a program.

B, 1, 58

Gutman, Fredrick T., "ASME and Metric Conversion,"
Mechanical Engineering, Vol. 93, No. 4, April, 1971,
pp. 38-42.

This is the report of ASME's metrication committee. It discusses problems of parts availability, education, equipment replacement, costs and dual dimensioning. Hard conversion is recommended. Threaded fasteners are also discussed.

B, 1, 59

Hale, F.M., "Metrication of Speed Limit Signs," Traffic Engineering and Control, Vol. 11, No. 10, April, 1970.

The author discusses a plan for abrupt change of speed

limit signs in England. Several plans are put forth and the advantages and disadvantages of each plan are discussed.

B, 1, 60

Hamilton, J.D., "Going Metric," The Engineer, Vol. 221, March, 18, 1966, pp. 150-151.

The author discusses the effect of metrication on engineering, with emphasis on hydraulics. Equations, units and rationalization are discussed.

B, 1, 61

Hammond, Harold P., "How Transportation Views the Metric System," Handling & Shipping, Vol. 12, No. 4, April, 1971, pp. 64-7.

The author presents general histories of metric usage in the U.S. and the world. The histories are followed by opinions of metric impact by the Federal Aviation Administration, the Federal Highway Administration, the Urban Mass Transit Authority, the Federal Maritime Commission, the U.S. Coast Guard and the Office of the Secretary of Transportation.

B, 1, 62

Harris, Raymond G., "Architecture -- Private Sector," presented at the Metrication Board Conference on Civil Engineering, London, July, 1971.

The problems that the architect must face during metrication are discussed. The author lists new module sizes for offices, shops, hotels, and houses. Changes in dimensions, administration, scales and costs are discussed.

A listing of available metric components is made.

B, 1, 63

Hector, A.M. and Barry, E., "Working Paper on Metric Conversion," Journal of Paint Technology, Vol. 45, No. 582, July, 1973, pp. 45-47.

Four methods of conversion, from transliteration of dimensions to complete package innovation are discussed. Possible new sizes of paint containers are given.

B, 1, 64

Hopkins, Robert A., The International (SI) Metric System and How it Works, 2nd revised ed., AMJ Publishing Company, Tarzana, California, 1974.

This is a very complete and comprehensive work on the metric system. The history of the SI and its standing in this country are discussed. All of the units are presented along with rules for their use and presentation. Also given are many conversion charts and tables. Aspects of metrification in Engineering Drawing, Standards, Home Economics, Materials, Paper Sizes and Education are discussed.

B, 1, 65

Hosking, J.R., "Metric Test Sieves for Highway Engineering Purposes," Technical Note TN 460, Road Research Laboratory, Crowthorne, England, Nov., 1969. (unpublished)

The author lists 23 preferred test sieves that the Road Research Lab (RRL) recommends for use in writing new

B, 1, 65 (cont.)

metric based highway engineering specifications. In addition to the 23 preferred sizes, 72 other sizes are allowable in special circumstances.

B, 1, 66

Howgate, Ian, "Metrication -- Metric Screw Supplies -- Breaking the Vicious Circle," Electrical Review, Vol. 189, No. 10, Nov. 1971, pp. 340-1.

The author describes the "chicken and the egg" problem that existed for British Industry in the area of metric screw supplies. Also described is the solution proposed jointly by the British Standards Institute, the Confederation of British Industry, the Metrication Board, and trade associations.

B, 1, 67

"Hydraulic Calculations for Sewers and Surface Water Drains in Metric Units," Technical Bulletin No. 4, Concrete Pipe Association of Great Britain, Brenchly, England, 1972.

This publication gives recommendations for computing surface runoff, foul drainage (quantity of sewage and trade wastes), flow in open channels and strengths of concrete pipe -- all in metric units. Recommended units for use are listed and program for metrication of concrete pipe is discussed.

B, 1, 68

Isaev, B.M. and Burdun, G.D., "Practical Use of the SI Units," Measurement Techniques, Vol. 8, No. 8, Aug., 1970, pp. 1137-45.

This article consists of a series of abstracts of 21

B, 1, 68 (cont.)

B,1

papers presented at an International Conference of the ISO held in Brussels in 1969. The papers cover five thematic areas: The use of SI units in (1) Mechanics, (2) calculating power and energy, (3) mechanics of liquids, (4) the building industry and (5) measuring instruments.

B, 1, 69

"It's a Metric World," Commerce Today, Vol. 1, No. 2, Nov. 2, 1970, pp. 9-10.

The article is a summary of a report presented by Lord Ritchie-Calder, chairman of England's metric conversion board, entitled "British Experience in converting to metric." A sketchy summary of Britain's conversion plan is presented.

B, 1, 70

Johnson, T.A., "Metrication Matters," Royal Institute of Chartered Surveyors, Dec., 1971.

This publication deals with those facets of metrication which affect a surveyor. Topics of discussion include metric units, plans, measurements and equipment, urban and rural real estate, rating and valuation, building surveying, and town planning.

B, 1, 71

"July 1 was "M" Day for Australian Roads and Real Estate," Metric Reporter, Vol. 2, No. 14, p. 5.

For the metrication of both roads and real estate, the article discusses, timing with respect to the overall national metrication plan, new units to be used, and publicity.

B, 1, 72

Kroeze, Henry, "Training Your Work Force to Think Metric,"
American Metric Journal, Vol. 1, No. 1, Sept., 1973,
pp. 23-5.

The author answers the following questions about metric training: when to do it, who needs training, who should do the training and how to do the training. Most of his comments are directed toward the engineering profession.

B, 1, 73

"Let's Go Metric (But Not with SI)," Chemical Engineering,
Vol. 79, No. 16, July 24, 1972, pp. 141-4.

The author makes the following arguments against SI: the pascal is too small a unit, the second is often an inconvenient unit for time, and pump characteristics in "head", which are easily visualized, would be discontinued. In favor of the SI are its coherence and distinction between force and mass. The author favors adoption of the cgs system and points out the necessity of learning to "think metric."

B, 1, 74

McEwen, E. Hill, R. and Butcher, F.E., "Britain Pushing
Switch to Metric, Canada Lags, Awaits Move by U.S.,"
SAE Journal, Vol. 78, No. 2, Feb. 1970, pp. 46-47.

In 1970, Britain was pushing to complete most of their metrication by 1975. The possibility of doing so looked doubtful, however, due to problems in education. Canada was feeling pressure to convert, but they decided to wait for their major customer, the U.S., to make a move.

B, 1, 75

B,1

McEwen, Ewen and F.E. Butcher, "Some Aspects of Metrication in Britain," presented at the Society of Automotive Engineers mid-year meeting, Chicago, Illinois, May 19-23, 1969.

This paper discusses and evaluates the psychological, administrative and technical aspects of metrication in Britain. The general acceptance of metrication by industry is discussed as to how it affects the implementation and publicity of the metric system.

B, 1, 76

"Main Roads Go Metric," Commissioner for Main Roads, New South Wales, Australia, 1974.

Designed as publicity for the motorist, this pamphlet gives the details, through illustrations and descriptions, of what the driver should expect after Australia's main roads "go metric" in July, 1974.

B, 1, 77

"Manual for the Operation of Changing Signs to the Metric System," National Association of Australian State Road Authorities, Sydney, 1972.

This manual describes the plan adopted by Australia to change their road signs to the metric system. Methods required for changing any sign in any situation can be found in this manual. Also given are diagrams showing what certain signs should look like after conversion.

B, 1, 78

Marklew, J.J., "Going Metric -- Some Experiences of an Engineering Company in Making the Transition,"

Machinery and Production Engineering, Vol. 119, Aug. 11, 1971, pp. 201-5.

The author described Whiteley, Lang & Neill's Ltd., program for metric conversion. Included in his discussions are; timing of the change, cost estimates, dual stocks, transition arrangements, employee compensation and employee training.

B, 1, 79

A Metric America, U.S. Department of Commerce, Washington, D.C., July 1971.

This is part of a three year study done by the Department of Commerce on changing to the metric system. The study concludes that the United States will eventually change to the metric system and that it would be better to do so by plan. The report stresses the need for early conversion of engineering standards.

B, 1, 80

"Metric Conversion Board Recommended Application of SI Units in the Land and Surveying Sector," Land and Surveying Sector Committee, Metric Conversion Board, St. Leonards, Australia, Mar. 28, 1972.

Recommended units are given for length, area, volume, angular measurement, temperature, pressure and frequency. Rounding practices are discussed. Precision practice of linear measurement is given. Scale ratios and contour intervals are listed.

B, 1, 81

B,1

"Metric Conversion for Australia," Metric Conversion Board, Canberra, Australia, 1971.

This publication gives background information on metric conversion in other countries and in Australia, Australian metric legislation, and the rules and recommendations for the use of metric units. In addition the Metric Conversion Board (MCB) is described -- its duties, function and organization. Each committee on the MCB is named and its personnel given. A list of places to contact for more information is given.

B, 1, 82

"Metric Conversion for Building and Construction: Design Notes," Metric Conversion Board, St. Leonards, Australia, June, 1973.

This pamphlet deals with the following aspects of metrication: timing, governmental authority, housing, preferred sizes, stud spacings, ceiling height, kitchen equipment, land titles, surveying equipment, training, contracts, handbooks, cost estimates, and building materials.

B, 1, 83

"Metric Conversion Information Brochure," Metric Conversion Board, Road Transport Sector, Transport and Communications Advisory Committee, St. Leonards, Australia, date unknown.

This brochure provides background information on the SI system and its use. The Metric Conversion Board is described as to its function and organization. The Road Transport conversion program is outlined and explained, including programs for freight, local goods and passenger transport.

B, 1, 84

B,1

"Metric Conversion Manual for Engineering Establishments,"
Metric Conversion Board, St. Leonards, Australia,
April, 1974.

This pamphlet gives metrication methods for design, drafting, production engineers, machine shops, and workshops. Changes in marketing and sales are discussed. Suggestions are made for retraining personnel.

B, 1, 85

Metric Handbook: Metric Conversion in Building and Construction, Standards Association of Australia, North Sydney, Australia, 1972.

This publication is a formally approved handbook on metric construction. It is designed to provide a uniform information base to facilitate coordination. Points discussed are: rules for using SI units, timetables, drawing practice, building materials, dimensional coordination, management of the changeover and training of staff.

B, 1, 86

"Metric Identification," Metric Memo No. M1, Aug. 19, 1971.

This issue lists the different ways in which metric products can be marked so as to differentiate them from imperial parts. Some ideas are using the metric key symbol, putting the symbol "Ⓜ" on the product, and, for very small items, the color blue. Consideration is also given to the possibility of imperial identification.

B, 1, 87

"Metric in Practice," Metrication in the Construction Industry No. 1, Ministry of Public Building and Works,

B, 1, 87 (cont.)
HMSO, London, 1970.

B,1

This publication discusses the background of Britain's metric changeover, SI units and Dimensional Coordination. Problems in introducing SI units are discussed, including programs, coordination, retraining and thinking metric.

B, 1, 88
"Metric Motoring," Metrication Council, Salisbury, Rhodesia, 1972?

This publication is intended to familiarize the Rhodesian motorist with the planned transition to metric measurements. Included are sections on speed limit signs, distance signs, fuel and oil by the liter, tire pressure, and automobile performance measures.

B, 1, 89
"Metric Practice in Drawing Office," Metric Memo, No. M17, May 31, 1974.

The status of applicable standards is discussed. Recommendations for paper sizes, scales, method of projection, dimensional expression, decimal markers, tolerancing, surface texture, threads, abbreviations and symbols.

B, 1, 90
"Metric Reference Book," Metrication in the Construction Industry, No. 4, Department of the Environment, HMSO, 1971.

This publication lists recommendations by the Ministry of Public Building and Works for the following areas of metrication: Policy, Quantity Surveying, Tendering, SI

B, 1, 90 (cont.)

B,1

usage, education of personnel, Surveying and Drafting, Preferred Increments, Dimensional Coordination, and others. A Bibliography is included.

B, 1, 91

"Metric 71," Amey Gravel Limited, Oxford, England, 1970.

Timetables are given for the commencement of deliveries of aggregate in metric units and invoices in decimal currency. Conversion tables relate kilogrammes, tonnes and tons and list old and new currency rates.

B, 1, 92

"Metric Sizes for Reinforcing Bars," Concrete, Vol. 2, August, 1968, pp. 326-7.

A table is presented giving imperial diameters and areas along with their metric equivalents. Also given are the percent changes in size between equivalent imperial and metric bars.

B, 1, 93

"The Metric System and Its Relationship to Road Transport," Road Transport Division, Ministry of Transport, Wellington, New Zealand, 1972.

This booklet is a programmed text to help drivers understand the metric system as it relates to roads. It is rather elementary but does cover all the basic concepts.

B, 1, 94

B,1

"The Metric System and Traffic Engineering," Traffic Engineering, Vol. 41, No. 4, Jan. 1971.

The author concludes that metrication is inevitable and suggests a plan for conversion. Seven problem areas in traffic engineering are discussed.

B, 1, 95

"The Metric World," South African Metrication News, No. 5, May, 1972, p. 3.

Part of this article concerned itself with the metrication of speed limits in Rhodesia. Other topics include metrication in New Guinea, the cost of not metricating in the U.S., and statistics on the world-wide use of the metric system.

B, 1, 96

"Metrication," Department of Trade and Industry, HMSO, London, 1972.

This is a report to the Parliament by the Department of Trade and Industry on the progress of metrication in Great Britain. Topics of discussion include historical background, international acceptance, effects on the consumer, freight transport, education and training, the Metrication Board, costs and benefits, and legislation.

B, 1, 97

"Metrication at Work Training Manual," Local Government Training Board, London, 1971.

This publication lays out a step by step program for retraining all types of personnel. Example tests applying

B, 1, 97 (cont.)

B,1

to various fields are given.

B, 1, 98

Metrication for Engineering Management; a Metrication Board Manual, Metrication Board, London, 1971.

This publication offers a step-by-step procedure for the engineering management to convert their offices to metrics. Background information on the SI system is given. Three case examples, all unrelated to highways, are studied.

B, 1, 99

Metrication in the States, The Council of State Governments, Lexington, Ky., 1970.

State Highway and other officials express their views on the costs and problems of going metric. The problems of highway engineers are discussed, including design, construction and operation facets. In addition, problems of a general nature are discussed (e.g., the length of the conversion period).

B, 1, 100

"Metrication Kit for Drawing Boards," Machinery and Production Engineering, Vol. 120, No. 3103, May 3, 1972, p. 633.

Size AO metric drawing paper will not fit on Anti-quarian drawing boards. This article describes two items made by DC reproductions which can extend old drawing boards so the AO paper fits.

B, 1, 101

B,1

"Metrication of Force, Stress and Loading in Structural Engineering," Structural Engineer, Vol. 46, No. 5, May, 1968, pp. 153-7.

The author gives his reasons for believing that the SI system is better and as convenient as the "common" metric system. Also given is an example structural design problem worked in SI units.

B, 1, 102

"Metrication of Land Measurement and Maps," Metric Memo, No. M15 (Revised), May 6, 1974.

Problems in converting real estate, maps, ordnance survey work and bench marks are discussed. A small conversion table is included.

B, 1, 103

"Metrication of Ordnance Survey Maps," Ordnance Survey, Southampton, England, Feb., 1973.

The following changes due to metrication are discussed: conversion of scales, bench marks, metric identification marks, and changes in contours.

B, 1, 104

"The Metrication of the Diameters of Pipes Produced Primarily for the Conveyance of Fluids and Used in the Construction Industry (Metric Units)," British Standards Institution, London, July, 1970.

This draft recommendation outlines the procedure to be followed in converting British Standards for pressure and non-pressure pipes to metric units. Appendices list ISO

recommendations, U.K. preferred steel pipe diameters, recommended metric diameters (nominal) and recommended nominal metric bores.

B, 1, 105

"Metrication of the Road Construction Industry," M7, South African Bureau of Standards, Pretoria, South Africa, July, 1970.

A committee consisting of representatives from several Provincial road authorities and the Department of Transport produced this report. Topics for discussion include metric units in road engineering, conversion of existing documents and the road construction industry metrication timetable.

B, 1, 106

"Metrication: The Legislative Position," Metric Memo, No. M11, Dec. 3, 1973.

A history of measurement legislation is given and is followed by an assessment of the present legislative situation. Legal impediments to metrication are presented and methods of removal are discussed. The legal effects on weighed goods are discussed. The relationship between metrication and the operation of the European Economic Committee is analyzed.

B, 1, 107

Mettler, Albert J., "Survey of Selected European Standards and Methods," Canadian Metric Association, Fonthill, Ontario, Oct., 1969.

This report covers investigations in Finland, Sweden,

Denmark, Germany and Switzerland. The selected standards are discussed in terms of their applicability to the introduction of a nation wide metrication plan in Canada.

B, 1, 108

Michael, Harold L., "Final Report of Committee on Metric Usage," Institute of Traffic Engineer's (ITE), Washington, D.C., Oct. 9, 1970.

The report begins by explaining the ITE and indicating the extent of metric usage in traffic engineering. An analysis is made of the metrication experiences in other countries. The conclusion is made that metrication is inevitable. Evidence is given supporting the contention that a planned metrication program is superior to evolutionary metrication.

B, 1, 109

Monerieff, D.S., "The Change to the Metric System," Journal of the British Granite and Whinstone Federation, Vol. 7, No. 2, Autumn, 1967, pp. 1-10.

The author briefly discusses the metric conversion program for road engineering. The bulk of the article deals with the problems of metricating sieve sizes. The author sees metrication as an opportunity for rationalization rather than an exercise in arithmetic.

B, 1, 110

Moncrieff, D.S., "The Role of the RRL in Metrication," Road Research Laboratory, Ministry of Transport, Crowthorne, England, August, 1967. (unpublished)

B, 1, 110 (cont.)

The timetable for changing all activities at the RRL to the metric system is given, including suggestions for activities to start metrication immediately. The SI units are described. The programme for metrication in the Road Engineering Industry is briefly sketched.

B, 1, 111

Morse, T., "Metric Mix-up a Danger to Motorway Bridges," The Engineer, Vol. 236, May 10, 1973, p. 7.

The article points out dangers that can occur if metric and imperial parts, especially fasteners, are mixed. A case example is given.

B, 1, 112

Mortimer, John, "Metrication at Ford Saves Money and no Mistake," The Engineer, Vol. 234, No. 6052, March 9, 1972, pp. 34-6.

The author relates an interview with Norman Skinner, Ford's metrication chief. Skinner discusses costs and savings, training, design mistakes, and conversion of suppliers. He concludes that the benefits far outweigh the cost, training required is minimal and metrication causes no design mistakes.

B, 1, 113

Needham, C., "Programme for the Change to the Metric System in the Construction Industry," Institution of Municipal Engineers Journal, Vol. 94, May, 1967, pp. 142-3.

The article discusses the British metrication program as it applies to the construction of buildings. Some

B, 1, 113 (cont.)

B,1

suggestions on surveying, structural design and office metrication are given.

B, 1, 114

"New Geometric Standards for State Highways," Road Research Unit Newsletter, No. 31, June 1971.

Alignment standards for highways in New Zealand have been metricated. This article gives the new standards in the form of tables and figures along with brief explanations about how the new standards were obtained.

B, 1, 115

"News Release," Metric Conversion Board, St. Leonards, Australia, Nov. 23, 1973, pp. 1-2.

The Metric Conversion Board lists here the dates of conversion for raw materials used in construction. Conversion dates for the construction field are listed according to the state in which each date applies. State regulations concerning metrication of land surveys and titles are also given. A warning is made about converting late.

B, 1, 116

Noles, Robert, "Signs of the Times" (No Bibliographic Data Available)

The shapes, colors, and symbols of international traffic signs are explained in this booklet. A section on metric speed limit signs gives their characteristics, cost and information on the required materials. Also included are examples of the metric speed limit signs used in Huntsville, Alabama.

B, 1, 117

B,1

"Oral Expression of Metric Dimensions in Engineering,"
Machinery and Production Engineering, Vol. 119, No.
3075, Oct. 20, 1971, p. 592.

The author tells of the findings of a June, 1971 meeting of the RS/CEI Joint Committee on Metrication. The committee issued recommendations for expressing metric dimensions orally. The author discusses these recommendations.

B, 1, 118

"Paint," Australian Paint Manufacturers Association, Sydney, Australia, Date unknown.

This pamphlet includes sections on conversion dates, new units, tinting systems, prices, storage and conversion charts. References for further information are given.

B, 1, 119

"Paper Sizes," Metric Change Information Sheet, Metric Conversion Board, Sept. 25, 1973, p. 1.

This sheet gives conversion dates, metric units to be used, new metric sizes, and a list of relevant metricated Australian standards.

B, 1, 120

Parks, R.W., "Precast Concrete," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.

Metrication problems in the field of precast concrete are discussed. General observations, export considerations, costs and training are all included as topics.

B, 1, 121

Parr, F.E., "An Investigation into the Availability of Engineering Design Data in SI Units," Standardization, No. 90, Sept., 1972, pp. 2-4.

A survey was taken to see where most engineers obtain design information. From the results of this survey, a questionnaire was devised in order to find out if the most important documents uncovered in the survey have been metricated enough to allow metric contracts to be worked on. The conclusion is, that enough metricated information is available, except in the case of physico-chemical data.

B, 1, 122

"The Pascal as Unit of Pressure and Stress," MP14, South African Bureau of Standards, Jan., 1972.

This leaflet details the advantages of the SI. The conclusion is made that the SI unit of pressure, the newton per square meter, is an inconveniently long name. Therefore, the Bureau of Standards endorses the name pascal for the aforementioned unit.

B, 1, 123

Polk, L.F., "Metrication for the United States -- What Are the Options?," Mechanical Engineering, Vol. 91, No. 5, May, 1969, pp. 22-25.

The author discusses the United States' precarious position as the only industrialized nation in the world uncommitted to the metric system. He discusses the options that the U.S. has in this position and calls for a decision to be adopted on these options rather than submit weakly to indecision. Benefits vs. costs of metrication are also discussed.

B, 1, 124

"Precision Conversion of Dimensions," MPT31, South African Bureau of Standards, August, 1972.

Rules are given for rounding, converting tolerances and limit dimensions, rounding datum dimensions, rounding positional dimensions and converting untoleranced dimensions.

B, 1, 125

"Programme for the Change to the Metric System in the Construction Industry," PD6030, British Standards Institution, Feb., 1967.

A Bar chart showing the planned times of change for each part of the construction industry is given. Explanatory notes on each item in the chart are included.

B, 1, 126

"Progress in Changing to the Metric System," Concrete, Vol. 3, No. 2, Feb., 1969, p. 58.

The author outlines some of the recent progress in the metrication program for the construction industry. He discusses BSI training programs, timing of the change, textbook conversion, dimensional recommendations, unit choice, and the second edition of PD6031.

B, 1, 127

"Progress Report," Metric Advisory Board, Wellington, New Zealand, 1973.

This report includes information on the membership of the Metric Advisory Board and a summary of metric changes in New Zealand. In addition, reports of the chairmen of each sector committee are given.

B, 1, 128

"Progress Report (4)," Metric Notes, No. 27, Aug., 1973, pp. 1-4.

This article comments on the progress of dimensional coordination, metrication of materials, metrication of design aids, metric scales and activities in the private sector.

B, 1, 129

"Publicity Planned for the July, 1974 Roads Switch," MCB Newsletter, Vol. 2, no. 12, Oct., 1973, p. 1.

The Australians plan to switch their roads to the metric system in July, 1974. This article describes the Australian Department of Transport's planned publicity program.

B, 1, 130

"Putting Metrication into Effect -- Information and Liaison Needed," EM&D, Vol. 11, No. 8, 1968, p. 1247.

This is a very short article stressing the fact that available information and help on metrication is lacking.

B, 1, 131

"RTAC's Proposed Plan for National Metric Conversion of Road Systems," RTAC, Canada, 1973.

Two time bar charts effectively summarize the metrication dates of activities connected with Road Systems. An explanation of the charts is included.

B, 1, 132

"Recommendations on the Use of Operational Metric Units,"
E.E.U.A. Document No. 39D, Engineering Equipment Users
Association, London, 1971.

This document lists units for different physical quantities and the reasons why the E.E.U.A. has recommended each particular unit. Tables broken down into subject areas list physical quantities and the recommended units for each physical quantity used in that area of engineering.

B, 1, 133

"Recommendations on the Use of SI Units," E.E.U.A. Document No. 35, Engineering Equipment Users Association, London, 1969.

The SI is described and EEUA recommendations on which SI and non-SI units to use are given. Also presented are tables which list physical quantities along with their SI units and recommended non-SI units. The same tables can be found in ISO R-1000.

B, 1, 134

"Recommended Metric Conversion Program for Land & Surveying,"
Metric Conversion Board, St. Leonards, Australia,
June, 1972.

A bar chart shows the planned timetable for converting activities related to land and surveying.

B, 1, 135

"Recommended Metric Conversion Timetable for the Government Construction Sector," Metric Conversion Board, Australia, June, 1972.

B, 1, 135 (cont.)

A bar chart is given showing the years of metrication activity for such things as surveying, materials, bidding, design and personnel training. Some activities are compared with the timetable for nationwide conversion of the same area.

B, 1, 136

"Reinforcing Material," Metric Change Information Sheet,
Metric Conversion Board, Australia, Oct. 23, 1972,
p. 1.

The timetable for conversion of, and the units to be used in the area of Reinforcing Material are given. Metric Standards now published for this purpose are listed.

B, 1, 137

"Report and Accounts 1973," British Quarrying and Slag
Federation, London, England, May, 1974.

This publication is a report to the members of the BQSF of the status of the industry and of relevant industrial news items. Included is a short paragraph on time constraints for metrication.

B, 1, 138

Rimrott, Fred P.J., "Canadian Metrication Program,"
Engineering Journal (Montreal), Vol. 56, No. 4,
April, 1973, pp. 11-16.

The author describes the SI system and the political status of its adoption in Canada. The British experience is discussed, giving the author's view as to what Britain's mistakes were. Force and mass units are discussed, with

B, 1, 138 (cont.)

B,1

the author recommending the kilopond for force. Decimal commas are also recommended.

B, 1, 139

"S.H. Pavement Line Markings," Road Research Unit Newsletter, No. 33, Dec., 1971.

A description of geometric standards for pavement line markings is given. Eye height standards and drawing practices are mentioned.

B, 1, 140

"Scale Rules," Metric Change Information Sheet, Metric Conversion Board, Sept. 17, 1973, p. 1.

The specifications for metric scales, as given in new Australian standards are listed. The purposes of the scales are described.

B, 1, 141

"Scale Rules," MPT 11a, South African Bureau of Standards, Nov., 1971.

This leaflet describes the characteristics of the metric scale rules recommended by the South African Bureau of Standards. Illustrations of the rules are included.

B, 1, 142

Sellers, Robert C., Reference Handbook for the Proper Usage of Metric-SI in Science and Engineering, Robert C. Sellers and Associates, Inc., Floral Park, New York, 1974.

This booklet describes SI units and explains how they apply to the physical units of length, area, volume, capacity, mass, weight, temperature, luminous intensity, speed, velocity, acceleration, force, density, pressure, stress, flow, work, energy, heat and power. The basis for preferred numbers is explained.

B, 1, 143

Sexton, F.M., "The Adoption of the Metric System in the Ordnance Survey," Geographical Journal, Vol. 134, Part 3, Sept. 1968, pp. 328-42.

The author discusses the policies and plans of the Ordnance Survey with regard to metrication. He points out that change to metric distances and metric bench mark heights will be fairly easy, but that changing contours will be difficult as they will have to be entirely redrawn. Decimalization of the scales 1:1250 and 1:2500 to 1:1000 and 1:2000, respectively is not likely to occur for a long period of time due to a shortage of manpower.

B, 1, 144

"Sheet and Strip -- Wrought Ferrous and Non-Ferrous," Metric Change Information Sheet, Mar. 12, 1974, p. 1.

This publication gives metric sizes, tells what units will be used for their measurement, gives availability dates and lists relevant metricated standards.

B, 1, 145

"Sober Realities of Metric Conversion," Engineering, Vol. 201, March 18, 1966, p. 527.

The author discusses problems of dual inventories and design. Emphasis is placed on conversion and design of screw threads. A warning about using wrong size screws is given.

B, 1, 146

Sokol, Louis F., "Status & Progress of Metrication Throughout the World," Traffic Engineering, Vol. 42, Nov. 1971, pp. 46-9.

A general overview on the metrication programs of other countries is followed by a short discussion on the metrication of road signs.

B, 1, 147

Stephan, Harold O., "Statement on Metric Conversion," presented before the subcommittee on science, research and development of the House committee on science and astronautics, Mar. 21, 1973.

The author describes the experience of labor problems that occurred when Allis-Chambers attempted a metric project. The problems were solved by well conducted metric training programs, which the author describes.

B, 1, 148

Taylor, Kenneth H., "The Impact of Converting to the Metric System," MSU Business Topics, Vol. 17, No. 4, 1969, pp. 50-60.

This article includes a short history of the metric system and a description of the SI. Pros and cons are given on the subject of metrication and the probable impact

B, 1, 148 (cont.)

B,1

of metrication on corporations is discussed. It is concluded that metrication is desirable, and recommendations for structuring a metrication program are made.

B, 1, 149

"Testimony of Nationally Representative Groups," U.S. Metric Study Interim Report, Vol. 12, U.S. Department of Commerce, Washington, D.C., July, 1971.

Comments are given by materials suppliers such as ACI and AISI. Also giving testimony is ARBA. Comments are provided by many other organizations not dealing with highways.

B, 1, 150

Tunnel Cement Limited, communication to users, London, Oct. 26, 1970.

This is a letter informing purchasers of Tunnel cement that metric deliveries will be made after January 1, 1971. Explanations of metric sizes and decimal prices are given.

B, 1, 151

"Units for Use in Design and Construction," Metric Notes, No. 18/19, Nov./Dec., 1972, pp. 2-14.

In order to provide consistency between design disciplines, this publication has been produced. It lists the units that should be used to describe corresponding physical quantities in each of 8 different disciplines

B, 1, 152

B,1

"The Use of SI Units," British Standards Institution,
London, 1969.

The pamphlet tells what the rules of usage are in the SI system and expand upon this with the BSI's point of view on certain non-SI practices.

B, 1, 153

"The Use of the Comma As Decimal Indicator in Practice,"
MP9, South African Bureau of Standards, Dec., 1971.

The Metric Advisory Board has recommended the use of the comma as a decimal indicator. To allay confusion, 8 detailed recommendations are given here to guide the user of the metric system and the decimal comma.

B, 1, 154

Vallis, J.W.M., "The Effect of Metrication on Highway Engineering," Journal of the Institution of Highway Engineers, Vol. 16, No. 2, 1969, pp. 3-14.

This is a very precise and to the point article covering all phases of highway engineering from design to construction. New tables of design data are given along with an explanation of how they were drawn up. Maintenance, signs, design of structures and geometrics, materials, drawing, surveys, costs, pipes, programs for change, mapping and choice of units are all covered.

B, 1, 155

Vincent, R.H., "Civil Engineering Contracting," Presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.

B, 1, 155 (cont.)

B,1

The author discusses metrication problems of interest to the civil engineering contractor. Included in his discussions are surveying, timetables, costs, units and rules for their use, retraining of personnel, tendering and construction.

B, 1, 156

Walley, F., "Metrication," Institution of Civil Engineers Proceedings, Vol. 40, May, 1968, pp. 107-115.

SI units and their application to Civil Engineering are discussed. Also discussed is Britain's conversion program. Highlighted are scale conversions, surveying problems, construction and design conflicts and the newton-kilopond controversy.

B, 1, 157

Wandmacher, Cornelius, "Metrication: Is SI for US?," Engineering Education, Vol. 61, No.1, Sept./Oct., 1970, pp. 49-53.

This article describes the metrication situation in the U.S. and the rest of the world. A description of the SI system, including a complete chart, is given. Engineering standards are discussed as well as the debate over stress units. The author concludes with the policy of the American Society of Engineering Education on the Subject of metrication.

B, 1, 158

Warren, J.W., Metric Change in the Building Industry, New Zealand Metric Advisory Board, Wellington, New Zealand, 1973.

B, 1, 158 (cont.)

B,1

This report discusses the effects of metrication on the following topics in the building industry: dimensional co-ordination, building materials, standards, bylaws, local authorities, metric drawing practice and reference documents.

B, 1, 159

Weihmiller, H.E., "Notes on Conversion to the Metric System,"
U.S. Government Printing Office, Washington, D.C., 1965

This is a report of the Committee on Science and Astronautics, U.S. House of Representatives (89th Congress). The report gives a short history of measurements followed by a description of metrication in foreign countries, including India, Japan and U.S.S.R.. Possible problems in converting to metrics in the U.S. and the U.K. are discussed. A summary of the advantages and disadvantages of metrication is made.

B, 1, 160

"Weightpieces for Testing Apparatus," MP13, South African Bureau of Standards, June, 1971.

Stressed in this publication is the difference between force and mass. Mass pieces are calibrated by comparison with other mass pieces and are good anywhere. On the other hand, weightpieces are local as they depend on the local gravitational acceleration.

B, 1, 161

Wellman, F. and M. Avery, "Training Your People to Work in Metric Units," Metalworking Production, Vol. 114, No. 31, 1970, p. 27.

B, 1, 161 (cont.)

B,1

The authors first discuss the problems of retraining. Then, they break down personnel into different groups and indicate the kind of training applicable to persons in each group.

B, 1, 162

"Why the Comma As Decimal Marker," MP7a, South African Bureau of Standards, April, 1973.

The switch to a comma decimal is a radical change. Many people ask why. The Bureau of Standards lists 10 of the reasons in this leaflet.

B, 1, 163

Wynn, A.H.A., "The Adoption of the Metric System in the United Kingdom," Chemistry and Industry, No. 44, Nov. 2, 1968, pp. 1512-6.

The article describes, in general terms, Britain's switch to the metric system. Included are recommended units and how they should be used.

Section 2. Summaries of British Interviews

British Taped Interviews

Three members of the metric research team, Mr. Meacham, Mr. Besch, and Dr. Bishara, conducted a two week field trip to England. Between July 22, 1974, and August 2, 1974 the British Government arranged for 17 interviews between the research team and various public and private agencies. The list that follows contains the name, location, and persons interviewed for each agency along with the date of each interview and a brief statement on what the discussion covered.

B, 2, 1

Department of the Environment

Engineering Intelligence Division

London, July 22, 1974

Mr. J. M. Guthrie

Mr. N. Glanville

Mr. W. Croucher, Traffic Engineering Division

A general discussion on how the D.O.E. handled metrification. Major subjects covered include: units, costs, time frames, laws and contracts, public reaction and the metrification of specifications.

B, 2, 2

Metrication Board

London, July 23, 1974

Mr. N. Stone, Chief Information Officer

Mr. C. Wright, Deputy Chief Information Officer

Mr. J. Beilby, Construction

Mrs. P. Jolly. Education and Industrial Training

The interview touches upon a number of broad topics such as: education, construction, engineering, food stuffs, agriculture and clothing. With respect to highways, units, costs and public reaction are discussed. In general, advice is given to create a metrication agency early in the conversion period, write and enforce metrication laws and set firm deadlines as to when all items must be metric.

B, 2, 3

Greater London Council

Planning and Transportation Department

London, July 23, 1974

Mr. R. Stelfox, Assistant Chief Engineer, Projects

Mr. C. S. Housden, Structural Design Engineer

The talk revolves around the subjects of metric units, materials, and contracts. Also, general conversion by contractors is discussed along with the impact that metrication has on structural design.

B, 2, 4

B,2

Freeman, Fox and Partners, Consulting Engineers
London, July 24, 1974

Mr. N. J. Dallard, Highways
Mr. S. Turley, Structures
Mr. M. Smith, Contracts
Mr. A. Chambers, Highway Design

The majority of this discussion centers around metric units and the way in which they are utilized. The engineers oppose changing units in the middle of a project. Further talks touch upon metric materials and contracts.

B, 2, 5

Department of the Environment
Bridges Engineering Division
London, July 24, 1974

Mr. G. P. Mallett, Superintending Engineer
Mr. M. H. Wisniewski, Assistant Superintending Engineer

The conversations at this meeting deal with metric units and their uses, along with the availability of metric materials and how they are used.

B, 2, 6

Construction Industry Training Board
London, July 24, 1974

Miss R. Part

This interview explores many points involved with retraining construction workers. The main points that are discussed involve: who needs to be retrained and to what extent, testing of workers, methods of retraining and aids utilized, and the costs involved in retraining workers.

B, 2, 7

Federation of Manufacturers of Construction
Equipment and Cranes
London, July 25, 1974

Mr. J. Annetts, Director General

All topics are centered around construction machinery. The major parts of the interview deal with redesigning and modifying existing and future equipment, the retraining of manufacturing workers, problems of component suppliers and suggestions for conversion timetables.

B, 2, 8

British Standards Institution
London, July 25, 1974

Mr. R. Harrison, Technical Officer, Construction
Department

Mr. A. Jackson, Technical Officer, Metallurgical
Department

This interview emphasizes the importance of metricating standards early in a conversion program. The BSI has changed approximately 1200 standards to metric and does not dual dimension. In addition, rather than changing many prescriptive standards to metric, new performance standards have been developed in metric terms. The discussion also reflects upon a number of metrication methods and some advantages of the conversion.

B, 2, 9

George Wimpey and Co. Ltd., Contractors
London, July 25, 1974

Mr. T. Purton, Senior Estimator
Mr. E. Cussak, Chief Engineer

This contractor discusses his experiences with metrication as it effected his bidding practices, his retraining efforts, his utilization of existing equipment and materials, and problems involved with maintenance projects.

B, 2, 10

Local Government Training Board
Luton, July 26, 1974

Mr. K. Hemfrey, Senior Training Advisor
Mr. Butler
Mr. Perryott

The L.G.T.B. helps to retrain all types of public employees excluding high elected officials. In addition, they do some retraining of labor personnel and comment that their longest metric course is a maximum of 3 days.

B, 2, 11

Buckinghamshire County Council
Aylesbury, July 29, 1974

Mr. H. B. Royle, Deputy County Engineer
Mr. G. Roscrop, Road Improvements
Mr. Osmond, Finance Director

A lengthy general discussion by a typical county engineer's office as to how they handled metrication. Talks were centered around topics such as units, retraining aids, design standards, and equipment and materials.

B, 2, 12

B,2

Amey Roadstone Corporation
Sutton Courtney, July 30, 1974

Mr. H. Luce, Publicity Manager
Mr. R. Willans, Director and Chief Estimator
Mr. W. Brown, Site Agent

A.R.C. is a large diversified construction corporation that does design work, produces construction materials, and performs construction. The interviewers were able to visit the A.R.C. testing laboratory and a project site as well as talk with the engineering staff. Many topics were covered such as: advantages and problems with the conversion, retraining workers, metric contracts, metric equipment and materials, standards and specifications, units and public reaction.

B, 2, 13

Ordnance Survey
Southampton, July 31, 1974

Colonel R. C. Gardiner-Hill, Deputy Director
of Planning and Development Division and
Metrication Officer
Colonel Crawford, Assistant Director to Photographic
Surveys Division
Mr. Holt, Geodetic Control

The O.S. is a government agency that performs the control survey and mapping activities throughout England. The discussion encompasses units, map scales, timetables for conducting new metric surveys, and horizontal and vertical controls as they exist now and will exist in the future.

B, 2, 14

B,2

Transport and Road Research Laboratory
Crowthorne, July 31, 1974

Mr. G. B. Taylor, Visits Officer
Visited the Laboratory and the Research Section

The participants in this interview included engineers, scientists, and laboratory personnel from the T.R.R.L. Most of the conversation deals with the metrication of specifications and testing procedures.

B, 2, 15

Department of the Environment
General Water Engineering
London, August 1, 1974

Mr. O. C. Young, Directorate

This conversation primarily deals with the new metric pipe sizes and their tolerances.

B, 2, 16

Concrete Pipe Association of Great Britain
London, August 2, 1974

Mr. Ian Roney-Dougal

Again, this conversation deals with the new metric pipe sizes and their tolerances, but also covers topics on time-tables, pipe classes, manufacturing equipment and metric handbooks.

B, 2, 17

Cement and Concrete Association Research Station
London, August 2, 1974

Mr. W. Murphy, Construction Research
Mr. H. Mildenhall, Road Engineer

This interview centered around metrication of the cement and concrete industry. Metrication methods, time-tables, units, and retraining methods are topics covered.

Section 3. Summaries of Other (Non-British) Interviews.

An important phase of any metrication study involves the sampling of the "human reaction" of workers to their initial exposure to the use of metric units in a work task. This appendix provides such a sampling in the form of transcripts of interviews held with workers who participated in the Metric Project #3 (PER-188-03.84). Each worker was encouraged to "tell it like it was" in his own words. The interviewer attempted to draw out responses and make sure each important metrication phase of the work was discussed.

The following have been included to assist the reader to evaluate the interviews:

- Figure 1 is presented to give the reader some overview as to where the worker's duties fit into the design of the project.
- A short description of each worker's function and his work objectives is presented as an introduction to each interview.

In general each worker was able to improvise and complete his task using metric units. Needed (metric related) equipment and supplies were available or a substitute was found. Any needed metric policy was generated as required to "get the job done". Yes, there was initial confusion among some workers but this was overcome and the project proceeded with a normal degree of productivity. Most workers were in favor of the metric system.

Throughout the transcripts the letter "Q" represents questions or statements by members of the metric study team and the letter "A" represents the response of the interviewee.

B,3,1 Interview with Richard Sachs.

Mr. Sachs is the Design Engineer for District 5 and was responsible for the development of the construction plans from conception to completion.

DISTRICT OFFICE
(Plan Preparation Function)

CENTRAL OFFICE
(Review Function)

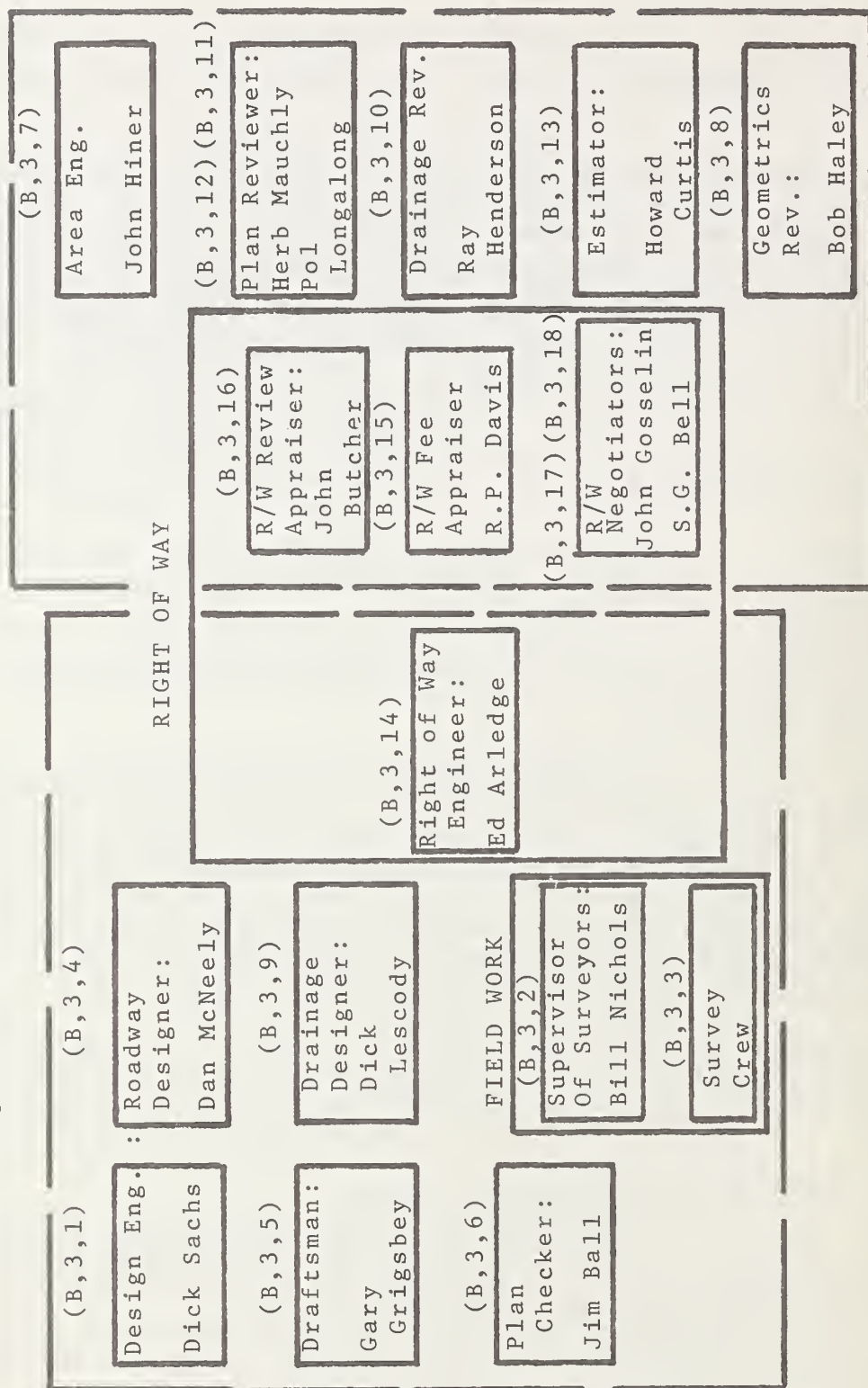


Figure 1 - Overview Of Workers' Duties On Metric Proj. #3 (PER-188-03.84)

B,3,1 (Cont.)

Q: Did you have any trouble getting scales?

A. We were able to purchase triangular scales easily here in Columbus...We also got steel pocket tapes and folding rules if we had any field work to do...

Q. What about cost?

A. We bought the intermediate grade scale. I don't believe there was any difference, maybe a dollar if any....

Q. Were they in stock?

A. Yes, K & E had those stocked....

Q. What about quality?

A. The same...

Q. Some people said there weren't enough to go around?

A. We bought enough only for design and R/W design...We felt the rest could get away with using a lesser scale...such as a 6" pocket scale...We didn't feel that at this time we should stock up on metric scales not knowing how much and how soon we'd use them again..

Q. How about paper and linen?

A. The linen was special purchased by Central Office when they decided to use the A-1 format...We were able to get metric x-section (grid) paper on a roll, to use in our preliminary work...We had originally put metric grids on our regular linen sheets for line sheets, but then they decided to use A-1 format...they would have been O.K. (the home-made).

Q. How much did the roll of x-section paper cost?

A. To be honest it was given to us by a K & E man from Cleveland with some graph paper and our first metric scale...I don't think it costs any more, its just a matter of changing the die...Now it might be more if you wanted some other size not stocked in that format.. K&E has a catalog with all its metric stuff in it...

Q. What about paper for prints?

A. We used roll stock we had & trimmed it...We couldn't use cut stock...

B,3,1 (Cont.)

Q. Did you look into the possibility of getting curve templates?

A. They have them in stock (K & E distribution) but they cost \$150 per set so we didn't feel the expenditure would be worthwhile...You can usually find one of the regular ones that gives a fairly good fit though once you've plotted the points...They tried to sell us a set though...

Q. Did you give your people any instruction before they started working on it?

A. No, I didn't...The big thing was getting to think in the units...At first we were going to use cm's and m's because a "cm" relates to an inch and an "m" to a yard...But Jorge Villacres (District Testing Engineer who attended specification meetings) said they wanted us to use "m" & "mm"...Think in m's and see so many "mm" as part of a "m"...I could see the reasoning so that's what I tried to get everyone to do...It's easy to visualize a metre as just a little bigger than a yard...As far as actual training sessions we didn't have any...We just got together with the conversion tables to decide how we would convert conventional units to metric....

Q. On the standard drawings what criteria did you use to decide what was converted directly and what was rounded off to more nominal metric dimensions?

A. I don't know if it was done that way, but manufactured items that were standard size were converted directly like guardrail and catch basin grates...anything where it was built in the field (and rounding had no effect) was rounded off...

Q. Did you have ASTM E380-72 as a guide?

A. It was about the only metric guide we had...

Q. Did you get necessary cooperation from Bill Gray's Office (Design Development)?

A. Yes, all we really had there was they supplied drawings on an A-1 format and we revise them ourselves...I shouldn't be critical but I didn't think District 10 should have rounded some of the manufactured items they did on their standards...

B,3,1 (Cont.)

- Q. The units used on your plan summaries, were they the ones in the specs that Fred Behn distributed...
- A. They were the ones in the specs...There wasn't any problem with that though...I thought that was the best idea using liters for liquid instead of m^3 ...
- Q. Did you have the specs to work with or did they come toward the end of the job?
- A. This job was done so fast everything came at the end... But we did have a copy of whatever was being proposed at each stage of preparation...
- Q. Do you have any knowledge as to why the 100 m D_{cm} was chosen?
- A. No, I don't recall anything about it...
- Q. What was the reason no spirals were used?
- A. The curves didn't call for them most likely...With the 100m definition the curve has a larger degree of curvature than it would with 100' definition so they look sharp but they're really not...
- Q. Vertical curve elevations were given every 5m opposed to the normal 25' do you think that may be a little too close?
- A. I don't know why they did that...It looks like they just took 1/4 of the +20 interval like 25' is 1/4 of a 100' station...
- Q. On the typical section some things were in nominal metric dimensions like pavement berm widths and others were direct conversions like pavement X-slope, was there any reason for this?
- A. No. That's the way they did it and it was sent to Central Office and came back without comment...I don't see why the slopes couldn't be made nominal, they're not inviolate. But no-one suggested it and we just left it as is...
- Q. We had one suggestion that we should have a separate metric "Typical Section" with nominal metric dimensions, how do you feel about that?
- A. That all depends on how many more and how soon we do them...If we are going to do many more, say 100, then we need a policy in metric giving like what nominal

B,3,1 (Cont.)

metric lane width should replace 12'...We (District) can't decide that has to come from policy...All we can do is convert the present policy and round off some where it won't matter...

Q. Did you give any thought to putting side slopes in percents?

A. No, I don't like that idea...Everyone is used to 2:1 etc. and its the same in both systems so why change it...It would just be confusing...It's easier for me to picture 2:1, 3:1, 8:1 than 50%, 33-1/3% and 12-1/2%.

Q. Was there any specific reason for the 100m stationing you used over that used by District 10?

A. Well the 100m station fit well on the A-1 format either 1 or 2 stations to a page...I noticed District 10's ran over 1 sheet to the next..I think ours is easier to find things on having whole stations per page...

Q. What about the "," in place of the "+"?

A. I can't see any reason for it, it's just confusing, just like % for side slope...Right off, the sizes of letters are hard to type...I think their stationing was based on how far you are from the County line... but with ours, all you have to do is subtract the beginning station from the station you're interested in and move the decimal and add to the beginning Strait Line Km to get the Straight Line Km location... It would be simple to start every job at Station zero.. I just don't think there's any confusion with +'s...

Q. What about confusing a metric plan with +'s with an English plan with +'s...

A. There would be the same problem with , 's.

Q. I meant only use , 's with the metric.

A. Anyone working with the plans could tell an English scale wouldn't give you anything on a metric plan. That's why we didn't use 1:600 scale like the R/W man suggested because its exactly 1"=50'...I told him that's exactly what you don't want to do...

B,3,1 (Cont.)

- Q. What if they left the comma out and left a space or just ran the thing together?
- A. Spaces are no good because of drafting and running together would make you write the whole number...with the plus on a plan you can write Sta. 16+00 and then +20, +40, +60, +80, and Sta. 17+00. Any other way you have to write 1600, 1620 etc...any less writing on a plan is an improvement...
- Q. Did you get adequate cooperation from Central Office on this phase of the work? Especially from Geometrics and the area engineer.
- A. He (the area engr.) didn't have anything to do with it.. I would have liked to have had faster replies to the things we sent in...Everything we did had the big red stamp "Metric" on it and was supposed to have 1st priority...We did get good service from Geometrics though.
- Q. Did you get any useful help as far as with the metric?
- A. There was little we needed here...
- Q. District 10 led us to believe the hydraulics was the hardest part of the job; Did you get that impression from your people?
- A. It seemed to work out pretty well...We got a metric contour map from Aerial Engr...ASTM had metric pipe sizes...We didn't have any trouble with Central Office. We asked for a drainage review and got it in a reasonable length of time....
- Q. Did you have any design aids in metric?
- A. I don't believe so. The hardest thing was making the design criteria in metric and having to convert everything back to use the charts and tables that we had to work with which were in English units...
- Q. Did your people complain or have favorable comments about working in the metric system?
- A. I think they liked the decimal system...It's easy to work with just moving the decimal points...They didn't seem confused...

B,3,1 (Cont.)

Q. What did you think of the paper size?

A. The A1 format worked out really well for the scales we used...We also had more room up & down on the plan sheet and this is nice if you would have an urban job with a lot of crowding on the page...

Q. What part of the job was most difficult?

A. The hydraulics, simply because we didn't have metric design aids...

Q. Did you look at District 10's drawings before you did yours?

A. No, because we were well into a job in Guernsey County (GUE) before they even started and we had our minds made up as to how to do them...the only things we changed from GUE was to use "mm" in lieu of "cm's"...

Q. What part of the work was easiest?

A. The calculations of any type because of the decimal system...

Q. Did the job take any longer work-hrs. wise?

A. I don't think so...We worked on it hard because of the deadlines...

Q. What could be done by Central Office to make the work easier before many more metric jobs are done?

A. You need a metric policy, specs, and standards...The specs we had were good for what we did...but in the end you'll need everything standardized in metric...

Q. For interim metric jobs do you think having a person in charge of coordinating the districts and Central Office bureaus in their efforts would be useful?

A. I'm sure it would help.

B, 3,2 Interview with William Nichols.

Mr. Nichols is the Supervisor of Surveyors for District 5. He purchased and distributed the necessary metric surveying equipment and coordinated all of the required field work.

Q. To start with, just tell us about the work done on the metric project.

A. There wasn't anything to the work...There's really no difference...We used decimals of ft. before and here we used decimals of metres...The biggest trouble was what kind of equipment to get...We used the regular instruments...We didn't know what type of tape to buy...It's pretty hard to cut or add a metre, your arms aren't long enough...The kind of tape I'd like to have had would have the last "dm" graduated in "cm" & "mm" and the rest of the tape graduated in "dm". It wouldn't have to be numbered every "dm" but every metre...The one we have now you have to estimate "cm" & "mm". I don't like it, but it's what we could get...

Q. What supplies did you have to buy?

A. A cloth tape, a 30m metal tape, and what I thought was a 4m level rod...It's actually 3m 7dm...It's a Philadelphia rod like the ones that are 7 ft. down and 13 ft. extended...When the metric rod was extended you read 3.5 3.6 and then on the overlap 2.0...You'd assume this is 4.0, but it's not; it's 3.7...That can be confusing if you read just below 2.0 and you don't remember that's 3.7 and not 4.0 because on the foot rod, 7.0 on the overlap when extended, is 13.0 ft. even...This problem is peculiar to a Philadelphia rod but that's the kind I like...

Q. What about the steel tape?

A. The first one we got was a tape on a reel...it was graduated well but it was flimsy and the reel didn't come off...It wasn't meant for highway work, it would not have lasted long...Fortunately, we lost it and then we got a highway chain, but as I said, it wasn't well graduated...But those were all we could get....

B,3,2 (Cont.)

Q. Where did you get them from?

A. Hills...

Q. What was the comparative cost?

A. The rod was \approx \$80, I could get normal ones for \approx \$40 if put up for bids...The metallic pocket tape I got didn't cost anything, it was given to me. It had come as a mistake.

Q. How was the rod to work with?

A. It was just like any Philadelphia rod to work with except for what I mentioned before...

Q. District 10 mentioned they liked the dots @ each "dm" which showed the whole metre with the appropriate number of dots....

A. Ours was like that too...that's fine...

Q. Did you give the crew any special instructions?

A. There just isn't a whole lot of training...They just have to start working with it...Now for me, I had to figure how to stake out the job...I chose 100m stations so I could easily use all the functions of a 1° curve which came out fine...We staked out every +20m because that worked well for cross-sections...The only trouble they had was in cross-sectioning and topo...The chain men would go out so far and say the distance but the party chief, who could normally tell it the distance given was approximately correct, had trouble doing this with the metric units...

Q. Did you pick a crew that you thought would have the least trouble?

A. No, I picked the one available at the time...

Q. Once the crew got used to working in the metric system was there any difference in the time involved to do the work?

A. No, because the work is the same...

Q. How do you feel about the plans leaving the curve angles in decimals of degrees?

A. I liked that because we have to use decimals of degrees to figure the curves...before you had to convert from

B,3,2 (Cont.)

A. minutes & seconds to decimals to figure them back to stake out...Now we just have to do it once...

Q. Were there any more errors on this job than normal?

A. At first, until they caught on...After about a week there was no difference...

Q. When they left the job and came back, did they have any trouble readjusting?

A. You'll have to ask them. They never said anything to me...I think they did have some trouble going from a "+" to the next station...

Q. What accuracy did you use on horizontal measurement?

A. We went to mm, because the first tape read them to the mm...But the mm is plumb bob string...but a cm's too much...compared to the 1/100 ft...Why not use the cm...

Q. How about profile, etc?

A. On cross-sections we read to the cm, which is more accurate than usual (1/10 ft.)...The rod reads to cm and you can read to mm with the target & vernier...

Q. Did the crew have any complaints about using the rod for lock-leveling X-sections?

A. No...

Q. District 10 complained about it having only 3 even heights since they lock on even heights...

A. We don't do it that way...We do it just like with the instrument...

Q. Could you have used a longer rod? Similar to 25' rod..

A. No...We always used a 13' rod...the only thing a 25' rod is good for is borrow pits...

Q. How do you feel about conversion to the metric system?

A. In our line of work it doesn't make a bit of difference. We'll just be using decimals of a different unit...

B,3,3 Interview with Survey Crew

The District 5 Survey Crew responsible for the field work required in the preparation of plans included:

Rod Ennis - Party Chief, Steve Paxton - Instrument Man,
Tim Paxton - Head Chainman and Mike Schwartz, Rear Chainman.

Q. What did you think of the equipment?

A. That could be changed a bit...Quality was O.K...The chain we have now isn't graduated down far enough...It should go to the mm...The rod when extended goes from 3.5, 3.6, to 2.0 on the overlap (show rod) that's confusing...

Q. That looks like a standard 13' Philadelphia rod with a metric face on it.

A. I think that's what they did...(shows chain) you can see what we're talking about on the chain, it's only graduated in dm's all the way through, but that's all.. The first tape was thin and on a reel, it wasn't worth anything...The cloth tape (show cloth tape) reads down to 2mm...The first metal tape also measured that accurate, it was easier to measure with...but it was awkward dragging that case around all the time...With the second chain you had to estimate everything below 1 dm which is $\approx 4''$...

Q. District 10 said they made a pencil mark and then measured that part with a pocket tape.

A. You could do that...but what we need is an extra dm on there making it an add chain with that extra dm graduated...I don't think that would be too difficult to do...

Q. Bill said you (Rod) had a little trouble estimating distances off in the metric units when on topo and X-sections?

A. Yes, when working in feet I can look out and tell if they dropped 50' in the reading they gave me...with the metric I couldn't do this at first, but I got used to it...

B,3,3 (Cont.)

Q. How long did it take you to get used to working with the metric equipment?

A. About a week...

Q. When you left this job and then had to come back to it, was there any readjustment problem?

A. A little...a day...1/2 day...1 hour...

Q. Do you think you made any more errors?

A. No, but we were checking ourselves very close, otherwise we may have...

Q. Did this slow you down any?

A. At first but after awhile we just went right along...

Q. (Pointing out the rod) I noticed that you put the whole metre number in red under the black dots. Did you do this because it shows up better than the dots?

A. When you're real close to the instrument, you may even miss the dots...at a long distance, the dots are hard to see too...The dots help you but you still have to add the number...

Q. Did you do any curve calculations?

A. Yes, because the tables we had were based on the 100' degree of curve...the size of the numbers kind of fool you at first, like a 15° curve metric is actually only a 5° curve in the other...They're not as sharp as you think...but you get used to it...

Q. What accuracy did you work to on line?

A. To the mm.

Q. How about elevations?

A. On X-sections to the cm...for ground shots we started to use dm's but went to cm later...on benches to the mm...

Q. Did you use a target?

A. We did at first...but we got away from it...we were checking within 3 or 4 mm...mm's are kind of fine but you need them for benches...for elevations on ground shots though a dm would be good enough...

B,3,3 (Cont.)

Q. What did you use the cloth tape for?

A. X-sections & benches...We put the line in with the chain the first one, we've only had this for a short time...

Q. It's funny the cloth tape is to the nearest 2 mm when you really don't need that accuracy for topo and X-sections but the good chain isn't...

A. That's what we said...It just doesn't make sense...As I said, we need an add chain with an added dm marked off finer...Still, a mm less than the head of a tack...

Q. What do you think would be an adequate alternative if the mm is too fine and the cm too rough?

A. I think we could use the mm if the last dm was marked to the mm...

Q. How about your accuracy comparison on closure?

A. About the same....

Q. Did you get any training to use the equipment?

A. "Here she is, go to it"...Bill went out with us the first day and gave us a little bit of an idea...but there wasn't that much to it...the only trouble I had was to get adjusted to how far, say .30m was...

Q. If you wanted to estimate a distance you could use a pace as an "m" instead of a yard...

A. That's what I started doing, thinking in yards...

Q. What did you think of the "+" stationing opposed to District 10's method?

A. It's easier for notes...but you have to watch when staking out +'s what the last "+" was because your tape is only part of a station...

B,3,4 Interview with Dan McNeely

Mr. McNeely is a Roadway Design Engineer for District 5 who did the geometric design, prepared the plans, and aided in the development of the metric criteria.

- Q. Did you have any trouble getting equipment?
A. As far as I know we didn't have trouble getting scales, linens, or X-section paper...We never got print paper we had to use roll stock and cut it to size...
- Q. Where was it decided what to use for the typical section?
A. We decided here in District Design...
- Q. Did you change any of your design aids, charts or horizontal curve tables?
A. No...
- Q. Did you work everything in metric?
A. Yes, there wasn't any problem using these forms...
- Q. How did you check site distance?
A. We had to convert back to use these charts...
- Q. How come you used 5m increments for giving vertical curve elevations instead of 10m which is close to the normal 25'?
- A. I always thought 25' was too far apart in the first place...since the tangent sections were so short I just continued it for the whole job...Had they (tangent sections) been longer, I would have used a greater interval for them...
- Q. You didn't have metric horizontal curve templates. How did you draw these in?
A. Just used the best fitting curve we had...
- Q. On the typical section some things were nominal metric like pavement & berm width while others like pavement X-slope were direct conversions. Was there any reason for this?

B,3,4 (Cont.)

A. Not really, it's just the way we did it...The slopes could have been rounded, we never thought of it though. We just took it off our normal typical...

Q. Now you used the normal ratios on side slopes, had you given any thought to using% instead?

A. No, it seems to me to be easier to visualize in ratio form...

Q. Did you have any trouble working with field notes?

A. I found it easy...They came all in metres. There was no problem...

Q. As long as you had the metric scale there was no problem there?

A. In fact, it was easier because the scales were larger.. We used 200m per sheet on the plan and profile sheets..

Q. On the standard drawings what criteria did you use for determining what was directly converted and what would be rounded?

A. Anything factory made we felt we had to call for exactly, while anything formed, we would just call even...

Q. How did you do them?

A. Bill Gray sent us copies on A-1 format...We eradicated what we didn't want, put a new coating on the linen and inked in what we wanted...

Q. How long did it take you to do that?

A. For all the drawings about a week...

Q. Did you know why the 100m D_{cm} was chosen?

A. No.

Q. Did you have any trouble working with it?

A. No, only that we didn't have the templates...You had to convert them to find the best fitting English template.

Q. Did you get any help from the Area Engineer?

A. No, I never saw him until the Field and Office Check (F.& O.C) meeting...We really didn't have a lot of problems...

B,3,4 (Cont.)

Q. Did you get any training before starting the job?

A. No, we just got together and decided what we would use for scales and how to change standards...I thought the scales we selected were very good to work with....

Q. Time-wise did it take you any longer?

A. No, it was just as easy as the others...

Q. Were calculations any easier?

A. Yes...there was less chance for error especially in earthwork & seeding...X-sections were @ 20m so all you had to do was add the two ends and multiply by 10...

Q. How was the decision made on the type of stationing used?

A. Dick Sachs made the final decision but we talked it over. The way we chose fit on many pages and made it big enough to see well...the 20m stations fit well with the metric sheets...

Q. What about the "+" vs the "," District 10 used?

A. We thought it would be rough to put all the little zeros in there on the plan and it's hard to type...

Q. Did you have the specs that Central Office converted at the beginning of the job or later?

A. We had the original ones which were later revised... The final ones didn't come until after the F. & O.C.

Q. How come you left the curve angles in decimals of degrees?

A. Bill Nichols thought it would be easier for the surveyors to calculate the curves that way...We talked it over and decided to leave them that way...

Q. Did you notice any more errors than usual?

A. No.

Q. How did you feel about working in the metric system?

A. It wasn't any problem, just getting used to the units... Once you worked with it and got used to the units I think it would be easier...

B,3,5 Interview with Gary Grigsby

Mr. Grigsby is a Draftsman for District 5. He drew the construction plans and computed the Estimated Quantities.

Q. Did you have adequate scales to work with?

A. Yes...but Ed Arledge (R/W Designer) said he didn't have one...some we got from other sources...

Q. Since you had no metric curve templates, how did you draw these?

A. Plotted them as best we could and connected them with a ships curve or RR curve that we had that best fit...

Q. The scale for plan & profile was a little larger than normal did you like this?

A. Yes. It gave you more room and you could see it better than on the usual 50 scale...

Q. Did you have any trouble with the X-section paper because it had a different grid than the 1" squares you're used to?

A. Not a bit...the only problem was conversion of rates and things like that...

Q. Did you have any trouble plotting field notes which were all in metric?

A. No. As long as I had the metric scale...

Q. Were plan quantities easier to calculate?

A. Yes...It seemed like most was just multiply or divide by powers of 10...

Q. You normally work with slopes like 3/16" per ft., did having this written as 0.0156 m/m confuse you any?

A. At first, yes, until I found it was the same slope with just a different way of writing it...

Q. How was calculation of the earthwork?

A. It wasn't any problem...just multiply by 10 with the 20m stations we used...

B,3,5 (Cont.)

Q. Were there any plan scales chosen that you thought could have been different?

A. We tried to pick at first what was nearly like what we used before and yet would fit the metric well...

Q. How about the time involved for the work?

A. I think it was quicker especially calculations of earth-work and seeding...just add and move the decimal...

Q. As far as drafting went?

A. Once you got used to the scales about the same as usual.

Q. How long did it take to get used to it?

A. Quite awhile before you really felt confident...I had to check myself a lot at first...

Q. Was there any difficulty in trying to pick a scale to fit a certain detail within a certain space...

A. Yes, because we're not used to thinking in terms of these scales...what I usually did was twirl the scale until I found the right fit...

Q. The detailer in the Bridge Bureau thought we ought to make a table comparing metric scales and English scales to make this part easier like $1:100 \approx 1"=20'$, etc. How would you feel about that?

A. I always thought that comparing the two systems is the most confusing part...I think you should just give some information about the metric system and let the person learn to use it alone not comparing all the time to the English system...

Q. Did you ever get pulled off this job and have to go back?

A. No...We did have some lag between the first job (GUE) and this one though...

Q. Did you have any trouble readjusting?

A. No, it was only a short time...It was no problem as long as you kept the metric fresh in your mind...

B,3,6 Interview with Jim Ball

Mr. Ball is a Plan Checker for District 5. He made a complete and independent check of the construction plans, quantities, revised standards and notes.

Q. Did you find more errors than normal?

A. In quantity they weren't materially different...but most of the errors were in location of the decimal point...the numbers are simple and it's too easy to lose track of the decimal location...

Q. Having all dimensions in one unit or decimals of one unit, did that make quantity calculation easier?

A. I didn't find that particularly different...The biggest trouble was converting units back to check things... All the rounding introduced errors when you tried to convert back to check with policy and standards...

Q. Others have said that in reviewing and checking you have to think a little more, you can't just look at something and tell if it's right by experience.

A. With these units, you can't trust your judgement...You can't really tell right away without converting back...

Q. In reviewing the plan, did you notice anything that should have been done differently in your opinion?

A. At first their nomenclature wasn't standardized, but they resolved that...I feel it should be standardized..

Q. What do you think of the larger scale they used on this? That's not really any trouble...but the standard size paper didn't work for prints, it's too small up and down for the metric size...

Q. Do you think putting vertical curve elevations every 5m was too fine compared to the 25' we normally use?

A. I don't think so on a sharp curve you should have closer intervals...It could be more though, for shallower curves...

B,3,6 (Cont.)

- Q. Did the fact that crown slopes were directly converted cause you any problems?
- A. It would have been better had they had a separate system (policy) on its own divorced from that we use with the English units...I taught Physics in college for 30 years back and we used the metric system...but that's no problem because it was separate from the other...When you try to relate the systems is when you get in trouble...You just have to think in the one system and you're O.K.
- Q. What is your opinion of the metric system?
- A. Personally, I'm opposed to it...(before the interview he indicated he thought it was a rip-off of the American people by money making concerns)...The simplicity of their system leads to errors...In our system we can look at it and see the errors, but with these new units, you can't rely on experience to see errors..

B,3,7 Interview with John Hiner

Mr. Hiner is a Roadway Design Area Engineer located at the Central Office. He was the coordinator between District 5 and the Central Office of all phases of the design thru the final construction plans.

- Q. John, we'd just like to ask you some general questions on this metric project and get your feelings on it. Were you involved in any way in the selection of the design standards when they started out such as pavement width and so forth when they were picking their metric equivalents to use?
- A. No.
- Q. If you weren't involved in that then, when you got into the review, the first one would have been line grading, typical, did you have any suggestions or changes there that you mentioned at that time?
- A. No, as I recall, it was just comparing what they had sent in with our current standards based on the amount of design traffic that was anticipated.

B,3,7 (Cont.)

- Q. They just picked as close as they could, I believe, to a 12' or a 24' pavement rather than rounding it to something good.
- A. I don't recall what the pavement width was, but in our system, if it were 20', the metric dimensions were as close to that as possible. Same way on shoulders and ditch widths and everything.
- Q. When you were reviewing the various submissions, did you, yourself, have any difficulty in grasping a metric concept?
- A. Well, of course, the plan sheets they used were different than what we're used to looking at. I had to make one of my own on paper.
- Q. That sounds familiar.
- A. Once you got some experience in it, it wouldn't be a problem, really. If the format or the plan sheets were all the same. I don't know where they got those things they used.
- Q. What do you mean, they were different? The stationing I know was different, the way they were using 100m stations.
- A. Right, but the profile, it just looked wierd. I can't describe it, but...
- Q. The ratio of the profile scale to the line was different than what they normally use?
- A. I don't recall.
- Q. Do you think that using metrics in a highway project makes the plan preparation easier or more difficult?
- A. Oh, I would say, once you were used to it, it would be neat. It would be just the same.
- Q. That's what I was wondering, if you thought it was more difficult, if you really attribute that to unfamiliarity with the metric system and not the metric system itself.
- A. It would just be not being familiar with it.

B,3,7 (Cont.)

- Q. I don't know if you got into checking any calculations or anything, but I wondered if you did if you thought it would be easier since you didn't have fractions to deal with, you don't have ft. and in. It's just a matter of moving the decimal point. Are calculations even easier using the metric system?
- A. Well, I didn't check any of them, but I imagine they would be. Somebody in Plan Review would be able to answer that. They reviewed the plan down there.
- Q. The only thing brought up, that was interesting to me, was the scales on the vertical and horizontal. I don't know if you worked with that.
- A. Well, it was the profile part of the sheet. It was just different to what we're used to looking at. I didn't know if it didn't have enough vertical grid or it was the gridding on it. They're farther apart instead of being little squares like everything else.
- Q. Was there difficulty in realizing, could you see any difficulty in realizing that it was a metric plan. If you just picked it up and looked at it? We had several that said that we should use comma stationing, District 10 used because that would help differentiate the plans and I was wondering if you'd think anybody could be confused that the plan that District 5 prepared wasn't a metric plan the way they had it laid out.
- A. If you just gave it to somebody that didn't know that the metric system had been used, I'd say, Yes. He wouldn't know right off it was metric. I don't recall if there was anything on the title sheet that said it was metric or not.
- Q. It was stamped on one of them.
- A. Without any identification I think someone would be into it a little before he would realize that.
- Q. District 5 still used the ratio on the slopes, didn't they?
- A. Yes, they did. Dist. 10 used %.
- Q. How do you feel about that, John? If they continued on and went and used % on the cross-slope instead of using

B,3,7 (Cont.)

- the ratio that they did?
- A. You mean 2:1.
- Q. Yeah, like in Dist. 10 they put 50%. They went whole hog on getting away from everything that's common to planning.
- A. I can't really say. It's a matter of equating it.
- Q. Do you have any comments on their plans regarding the metric or the way they did anything that we didn't catch?
- A. No. All of the comments would be from just looking at it. I would have had the comments if it were metric or otherwise.
- Q. In general then, we just handled this like any other plan then, and you check it for what you check it for and let them handle it.
- A. I only saw it twice, at the Line, Grade, Typical & the F. & O.C. I guess the drainage section did the drainage review. There wasn't any slope meetings & right-of-way held a right-of-way review. I don't know what problems they may have had there. I don't think they had too many. They only have 3 pages of comments here. There couldn't have been anything too serious. Marshall was apparently able to cope with it because he gave them pavement build-up in metric.
- Q. If you had your choice of switching over to metric or staying like we are what would your opinion be?
- A. I think it's going to be a matter of education and it would be really easy if we just would, I don't know what Dist. 10's plan looked like, what that scale was but if it was different from the one five did, we need a uniform system. Get some scales for people. I don't think there would be any problems.
- Q. They used the same scales but a different method of stationing.
- A. They did a few things different. The actual preparation and what they did and how they did it was the same, but things that mainly were different in the two plans were things that really didn't have anything to do with metric. The other thing that got most of the

B,3,7 (Cont.)

comments was slopes, cross-slopes, side-slopes on the thing. The big difference on it was on the standard drawings. Dist. 5 standards, they used the "soft" conversion on pre-fabricated items. Where Dist. 10 made a "hard" conversion, they used a more nominal metric distance for standard American distances.

- Q. That's going to be a big job with new standards & charts & tables & everything. I think once it's all available it would be just as easy if not easier.
- A. The basic thing is when you're talking about standard drawings & anything like that the actual work of doing the charts, the formulas, or anything is not difficult.

B,3,8 Interview with Bob Haley

Mr. Haley is a Geometrics Review Engineer with the Roadway Design Bureau of the Central Office. He reviewed the plans for conformance to the geometric design criteria and policies.

- Q. On the typical section did you prefer the use of ratios to the % used by Dist. 10?
- A. Yes, definitely (reason given in previous interview for HOC-93)...
- Q. How did you feel about the direct conversion of pavement slopes like 3/16" per ft. to 0.0156?
- A. It really doesn't matter to me whether it's oddball or not...They could change them though. They're not sacred.
- Q. How about nominal widths?
- A. It doesn't matter...these we use now are nominal in our system...They could have been another number...
- Q. How do you feel about giving vertical curve elevations every 5m?
- A. I don't think it needs to be that fine with all the innovations in highway construction...
- Q. Curve angles were left in decimals of degrees. How do you feel about that?

B,3,8 (Cont.)

- A. No problem as far as I'm concerned...I don't know about the surveyors, but many now use pocket calculators anyway...The problem is in getting deflection points for curves we must pick the right curves to use...The ones we use now are divisible by 4 like $0^{\circ}28'$ etc...so we can set out elevation and alignment on the same stake for convenience...
- Q. Did you like the method of stationing better than Dist. ten's?
- A. Yes, but I still object to the 100m length of station... In laying out +'s with 100' stations one chain went between stations and there was no confusion...But 100m chain would be too awkward to use...with a shorter chain you'd have to remember where you were...with a 20m chain you should have 20m stations and 20m curve lengths...Everything we use will have to fit the station length for convenience in the field.
- Q. Do you have any comments or suggestions not previously discussed?
- A. I liked Dist. 5's plan format better...I could find where I was much more easily...The biggest problem is that there is no unit in the metric system that fits present accuracy...the mm is too fine to work with, but the cm doesn't reach the accuracy we can attain in surveying & construction...You don't want to go back in accuracy...

B,3,9 Interview with Dick Lescody

Mr. Lescody is an Hydraulics Technician for District 5. He designed the drainage for the project, and provided the necessary information for the drainage details.

- Q. Would you discuss how you did the job?
- A. The only thing we did metric on the drainage design was calculation of design flood for the large culvert... I got a metric drainage area map from aerial engineering for the large culvert and ran through metric Bul. 43...Also because the contours were in metric allowable head was found in metric...The rest was done in English units and the results...We wanted to do it metric but we had such a short time to get it done...

B,3,9 (Cont.)

- Q. Had you given any thought to what would have been the best way to proceed had you done it all metric?
- A. I wish I had got all the drainage area contour coverage in metric from Aerial...
- Q. When you converted pipe sizes & ditch sizes did you use a direct conversion or round it off?
- A. ASTM already gives the converted pipe sizes in metric and I just used theirs...with gutter & sod widths I first converted directly but later we decided to round them off some...That was the biggest problem how to convert and round off everything like this and standard drawings...I had to go back and recalculate estimated quantities on some things when we rounded off...
- Q. Were these calculations easier in metric units?
- A. Yes. For instance in drainage calculations, areas in m^2 converts to hectares or km^2 just by moving a decimal point...
- Q. If Central Office had provided you with all the necessary design aids would you prefer to work it all metric?
- A. Well, having those aids would be a big help...
- Q. How much longer did the job take %-wise than if it had been done regularly?
- A. $\approx 25\%$ because of all the converting back and forth...
- Q. How did you work with allowable head?
- A. All elevations were in metric so the allowable head was determined in metric...I converted this back to use the computer program for culvert design...
- Q. How were the scales that you worked with compared to normal?
- A. The plan & profile scale could have been larger...The scale for culvert design worked out really well...
- Q. Was there anything about the metric design that you really liked?
- A. I can't say really...If we'd have had all the tools to work with it probably would have been easy...

B,3,9 (Cont.)

- Q. Is there anything Central Office could do to make another metric job easier?
- A. Well, they did send us some metric charts but I never got to use them...
- Q. We could assume then that at least for hydraulics it would help if you had metric design aids in advance?
- A. Yes! Definitely!. The job would be much easier and much less time consuming...
- Q. Did you get any organized training?
- A. No.
- Q. Was the approach any different going into this job than a normal one?
- A. There was no difference...they said this was to be a metric job now do it...
- Q. Did you have the revised specs at the beginning of the job?
- A. No...
- Q. Would it have helped to have them earlier?
- A. It really wouldn't make any difference...
- Q. If we did another job do you think it would be a good idea to ask them to design it all metric and allow sufficient time and give necessary aid?
- A. Yes...because if you ask if I learned anything I'd say no...We didn't do any basics; just do and convert over..

B,3,10 Interview with Ray Henderson

Mr. Henderson is an Hydraulics Review Engineer with the Roadway Design Bureau of the Central Office. He reviewed the plans for conformance to the hydraulics design criteria and policies.

Q. Did District 5 do anything different on this job than Dist. 10 did on HOC-93?

A. Dist. 5 went through a few more calculations in metric.

Q. Did they get some of the charts that will be in the manual that have dual dimensions?

A. They asked for them after they began...but I don't think they used them...they wouldn't really help them much...they just give the exact conversion of the English units...also they're basically set up for storm sewers finding normal & critical depth.

Q. I believe the manual has ditch or channel flows, did they use these?

A. These are still English charts a 1' depth is 312mm but for metric you would want a depth like 300 mm etc., these wouldn't help much.

Q. Are the necessary culvert charts or nomographs in the manual dual dimensioned?

A. I don't think they are...there would be no trouble to dual dimension culvert design aids for metric design...anybody could do it...

Q. With time the designer could do it?

A. Yes it would be no problem.

Q. If we gave them enough time to do it do you think the districts could design the drainage in metric without too much assistance from Central Office?

A. They could, but they would require some aid...

Q. Do you feel the work would be just as easy if they had all the charts to work with?

A. I think so. We do need some more charts done in metric.

Q. You feel that the Districts could convert the charts they needed?

B,3,10 (Cont.)

- A. The ones I'm thinking of they could easily...I just changed a couple of nomographs...They were simple and didn't take long..maybe 1/2 hr.
- Q. Did the districts ask for the charts, etc. they needed?
- A. Dist. 5 did but we didn't have them when they needed them...They did any metric calculations by hand...
- Q. The drainage designer said he had a metric drainage area map prepared for the large culvert but wished he had it done for the entire job? Do you think metric mapping would be a good idea for future metric jobs?
- A. It would be, yes, for keeping everything the same...It wouldn't really make a lot of difference only getting rid of one conversion needed to use English unit U.S. G.S. maps with metric Bul. 43...
- Q. Did it appear to you they had any more difficulty on the drainage?
- A. I don't think so...There wasn't that much drainage...
- Q. Were there more errors?
- A. No, maybe less...
- Q. Do you think they were more careful because this was something different?
- A. That's probably the reason (for less errors)...
- Q. In your comments on the drainage review was there anything related to metric?
- A. Dimensions on some of the hydraulic standards were inconsistently rounded...this was confusing...I didn't try to change this though...
- Q. Did you like their method of stationing better than Dist. 10's?
- A. Yes...It's more like what we're used to seeing...
- Q. Was this job easier for you?
- A. Yes...I knew a little more about it...

B,3,10 (Cont.)

Q. Did you use any metric charts?

A. No...just converted and used the computer program.

Q. How are the ASTM pipe sizes in metric rounded?

A. I believe to the nearest cm...

Q. Have any of your opinions changed because of the second job?

A. No...

B,3,11 Interview with Pol Longalong

Mr. Longalong is a Plan Review Engineer for District 5. He reviewed the final plans for completeness.

Q. Did you have any comments on the plans?

A. In callout in standards and plans, there are some conversions that have to be exact because we still will get the standard sizes while others can be rounded... Unless you get special manufacturing some items have to be converted exactly...things built in the field can be rounded there's no problem there...I made this comment on the F. & O.C. review...

Q. Do you think we should start thinking about what standard metric sizes we might be using in the future? In other words do you feel we should be ready to tell manufacturers what we want rather than waiting for them to see what they do?

A. I think so...

Q. Did you have any equipment?

A. No...I just put a scale on paper based on the plan scale...

Q. Could you have used a scale?

A. It would have been easier...

Q. Have you worked in the metric system before?

A. Yes....I was employed by the Bureau of Public Highways in my country...The work is quite similar to what I'm doing now...really only policy differs.

B,3,11 (Cont.)

Q. Did you notice any more errors than you would normally find on a comparable job?

A. Since we are in transition we can expect some minor errors...

Q. Did you find you had to do any more calculations because you couldn't tell from experience by looking at a figure it was about right?

A. I ran some calculations...but there wasn't much difference...

Q. Were the actual calculations much easier in the metric system?

A. It didn't make any difference to me since I'm experienced in both systems...others might have more trouble who weren't experienced in metric...

Q. Did you have the completed supplement to the specs? (Affirmative) Did you like the format or would you have preferred a separate spec?

A. I feel they should keep what they have here until the changeover to a spec based on a metric policy...

Q. What did you think of the units?

A. I think this was realistic more so than that originally proposed...like liters for liquid and m^3 for volumes depending on the materials...

Q. How do you feel about the way they left angles in decimals of degrees?

A. It's O.K. if they can work with it...

Q. How did you feel about the stationing?

A. For flat terrain, 20m for X-sections is O.K., but it wouldn't be for hilly terrain...

Q. What about the way they wrote it as opposed to Dist. 10 method?

A. The + is more realistic...that's what we used in the country I came from...with 100m intervals...

Q. Vertical curve elevations were given every 5 m as opposed to 10m on the HOC job. How do you feel about this?

B,3,11 (Cont.)

A. Either one is realistic...

Q. Side slopes on the typical section were left in ratios like 2:1. Do you prefer this to changing them to %?

A. I think there's no problem leaving it the way it is...

Q. How do you feel about the way they converted the pavement slopes directly?

A. That was alright...

Q. What about the rounding of the width?

A. That's right too as long as they stay within present policy...

Q. Besides scales which you didn't have and specs which you did, is there anything that could have been provided but wasn't?

A. A metric policy would help...

Q. During transition do you think a metric coordination committee or manager would be helpful?

A. In order to have a smooth flow you'll have to have an office to do this...

B,3,12 Interview with Herb Mauchly

Mr. Mauchly is a Plan Review Engineer with the Roadway Design Bureau of the Central Office. He made the final review of the plans for conformance to all policies, in preparation for a cost estimation.

Q. Comparing the PER & HOC jobs do you have any comments regarding the differences between the two?

A. Dist. 5 (PER) was more consistent in rounding off call-outs as far as I'm concerned...They didn't round pre-fabricated units at all which is more practical...but others they rounded which were built in the field... This is the way I'd like to see it done...I liked the side slopes left in ratios...2:1 is the same regardless of base unit...changing it (to %) is just confusing...This has nothing to do with the metric system.

B,3,12 (Cont.)

- Q. Dist. 10 used nominal widths and slopes on the typical section while Dist. 5 used nominal widths but converted pavement slopes directly. Do you have any opinion on this?
- A. It doesn't matter as long as it doesn't go beyond present policy...
- Q. Horizontal curve angles were left in decimals of degrees. Do you have any opinion on this?
- A. I can't see any reason to change it from degrees, minutes and seconds unless you want to change your surveying instruments...
- Q. Vertical curve elevations were given every 5m. Do you think this may be too fine?
- A. It depends on the sharpness of the curve...It could be useful in some instances while for less sharp curves 10m is O.K....
- Q. Were there any more errors on this job than a comparable regular job?
- A. I couldn't say...I didn't have time to check for small errors...
- Q. Was this job any easier than the first?
- A. Yes, things weren't as foreign to me...I knew where to look...having the completed supplement helped...it was easier on this job to check with the specs knowing they were final and correct...
- Q. Do you agree with the units chosen?
- A. It's hard getting used to the extremes of m to mm...
- Q. Were any of your opinions changed after doing the second job?
- A. No.

B,3,13 Interview with Howard Curtis

Mr. Curtis is an Estimator in the Roadway Design Bureau of the Central Office. He calculated the estimated cost of the project.

Q. How did you approach this job?

A. We converted everything back to English units, established the total item cost, and then took this to get the metric unit price...it took some time to convert back but that's all...On this job there was no overlap into another construction season assuming it would be built in 1975 only, so estimating was easy from this respect...Most of the items we just did normally... Now on a small job, we usually increase the cost of earthwork 10% but on this job, we increased it 20% because of what the contractor might get into...I reviewed my estimate after getting the list of bids for the HOC-93 job and changed a few based on what those contractors had bid...Such as project documentation on HOC, we were way below the contractor...There were some extreme items but they were small in quantity and the dollar value was insignificant...

Q. Did you work much with the specs?

A. Not really...by the time they (plans) get to us they are checked pretty well with regard to that...

Q. Were there any of the units chosen for pay quantities that gave you any problems?

A. The ones that gave me the most trouble were items that should be paid for in different ways...I made one error where there was a quantity in m^2 and it normally is paid in $yd.^2$ or $ft.^2$...I got mixed up, but Jake caught the error...Specials and lump sums present a problem too...This was a small job and didn't have many items...

Q. Did you boost your price a little because this was a metric job?

A. Yes, because I was hesitant in my work and I felt the contractor would be too...so I made my price strong...

B, 3,13 (Cont.)

- Q. Did you notice anything about the plans that you would like to comment on?
- A. The format was real good...They were easy to work with. There was nothing that disturbed me...This was a small job though...On a larger job where you have to work more with the plans there might be problems, but I didn't really have to work that much with the metric plans...I have saved all the metric information that passed my desk for several years...The conversion tables I had were quite handy...
- Q. Do you think that this information should be distributed to all the people who work on or with plans?
- A. I don't know...There might be ill feelings that this would be propaganda...It might just scare people also...
- Q. If they asked you to work on another metric job, would you?
- A. Yes, but I would fear a large job with a lot of earthwork which would require a mass diagram...The earthwork forms (for estimation) are already difficult in our system...for this I might not volunteer...Had we time to make a metric earthwork form, we could have learned something about the problems involved...
- Q. Would it be much work to change that form?
- A. Some of the others might be able to do it without much trouble, but I'd have some trouble...I think it would be a headache.
- Q. Once you had these metric forms and the cost of material printout in metric, would the job be any problem then?
- A. I don't think so, if the forms were all in metric...

B,3,14 Interview with Ed Arledge

Mr. Arledge is in the Right-of-Way Section for District 5. He determined Right-of-Way requirements and prepared deeds and easements.

Q. Did you have any trouble with getting equipment?

A. There weren't enough scales to go around...you had to chase one down...There were no metric RR curves...you had to use the best fitting regular one...

Q. How did you convert your deeds?

A. We converted directly rods, chains, ft., etc. to m... the only added work was converting the ft. to m...you have to convert others to ft. normally, anyway...

Q. Did you get any instruction before you began working on the job?

A. No, we just started working on it...

Q. Once the deeds were converted was all work done in metric?

A. Yes...up until the easements and deeds...The Perry County (PER) Auditor wouldn't accept metric alone, so we had to dual dimension those...The ft. were put in parentheses...They said they would accept that...

Q. Was there any difficulty in working with the different degree of curvature?

A. No, we have a computer calculator and it worked in whatever we put it in...

Q. Did any adjustments in the program have to be made?

A. No...just read m² in the ft.² printout column and convert that to hectares...

Q. Did you think of dual dimensioning plans?

A. Yes, but we decided against it...We thought the other district had dual dimensioning so we just left ours in metric...

B,3,14 (Cont.)

Q. Was this job easier or more difficult to do in the metric system?

A. There's no real difference in this work...

Q. Did it take longer?

A. Maybe a little bit because of unfamiliarity with units. But the work is the same except for the one extra conversion needed in the use of deeds...

Q. Did you notice any more errors?

A. No...

Q. How far did you carry out hectares?

A. Hectares to 3 decimals; acres to 2...

Q. We noticed your angles were in degrees, minutes and seconds opposed to the roadway plans being in decimals.

A. Our computer program used these so we did it that way...

B,3,15 Interview with R. P. Davis

Mr. Davis is a private appraiser who was contacted by the State of Ohio to appraise the value of property which was purchased for the Highway Right-Of-Way.

Q. How did you approach the appraisals?

A. We were requested to do it in both systems...This was a duplication of effort but not difficult...It would be no problem to appraise in the metric system except if during conversion they wanted it both ways, then it would be duplication of effort...

Q. You used the market data approach?

A. Yes...The cost approach is usually limited to special purpose property like schools and churches that there is no market for...There were no income producing properties but the income approach would not be a problem either...The market we used was in acres...I was not asked to convert the market but that would be easy...Actually it would have been simpler had I done that and worked all the way thru in metric...

B,3,15 (Cont.)

Q. Did you have any problems with the work?

A. No...only reading the plans there was an awful lot of information crowded into a small place or smaller parcels...

Q. Was there any dual dimensioning?

A. No...only the summary sheet had both systems...

Q. Was your report in dual dimensions?

A. Right...I have a metric and English appraisal...These are filed in Columbus...actually it would have been easier to just do it all metric...

Q. Do you think the metric system is easy to work with?

A. Yes.

Q. How do you feel about converting to the metric system?

A. I don't really care...if they do it, it should be a fast switch to avoid all the duplication of effort like I did here...

Q. For comparative sales you looked them up in customary American units?

A. Yes, but that wouldn't pose any problem if we converted right there and went thru the entire thing in metric...that would be easy...Now the negotiators might have a problem if it was all metric...

Q. Was your fee increased because of the way you did the job?

A. Yes...Normally a typical single family residence is \$300 we charged \$400 here...this would hold as long as we had to do it both ways...but if we did it all metric a larger fee might be justified only the first time...the total fee was \$2800 normally, it would be \$2300...

Q. Would it be any more of a problem with more complex properties with more buildings?

A. No, I already tested that on this job by working with the buildings somewhat.

B,3,16 Interview with John Butcher

Mr. Butcher is in the Right-of-Way Section for District 5. He reviewed the land appraisals for the required Right-of-Way for the project for conformance with State policies.

Q. What did your work entail on this job?

A. Review the appraisal for reasonableness & following of state procedure...As far as metric is concerned the appraiser really did that for me, all I had to do was read the plans and double check him...He prepared the report both ways...To check all I had was a few conversions and this was quite easy on a little calculator. The reviewer shouldn't have any problems with it if he has a good appraiser...

Q. Would working right-of-way be any more difficult in metric?

A. Once you're used to it I see no difference...

Q. This was all done on market data, there was no cost of replacement or anything?

A. Right...now the appraiser did not do his adjustments in metric which would have made a little more work for me...These adjustments are needed because no two sales are alike...You have to bring the market sale up to present date and also adjust on size and location, etc. These are cost/acre adjustments in rural areas...in the city this may be cost/ft³, cost/front ft., or cost/site but the way of doing the appraisals is the same...The adjustments in metric shouldn't pose any problem though...

Q. Actually then, how is the value of take figured in market data?

A. It's the difference of the value of property before and the value of the property after unless there are damages...

Q. Dist. 10's people indicated that the cost approach would be much more difficult to do in metric.

A. Well, yes, because it's based on measurements...Everything now is constructed, sold and built in our units and finding costs of replacement based on metric measurements would be difficult...All information probably

B,3,16 (Cont.)

A. would have to be converted...The only time you use this is if you have a building that doesn't really have a market, a special purpose bldg. like a church...this is very seldom though...

Q. Was any time added to your work then?

A. Very little...

Q. Do you think it was worthwhile doing the right-of-way plans and appraisals in metric?

A. Yes, it was interesting...

Q. Now you had to convert these back for the negotiators to do their work?

A. Yes, but it was quite simple on a calculator with a constant multiplier...

Q. Besides being interesting do you see any value in doing right-of-way in metric if the negotiators have to translate to the property owner?

A. Yes, for one reason...it will expose the public to the metric system...It's going to come and you may as well start familiarizing them with it...

Q. What problems did you have with the job?

A. The biggest trouble was getting hold of a scale...we tried to Xerox one on paper, but it didn't work; it got distorted...so we went out and bought one finally...

Q. Would you give us a brief summary of the 3 methods of appraising?

A. Market data -- which is the value in the market place.
Cost -- which is the cost of reproducing the property.
Income -- value from income which would be general by the property usually used as a back-up to market data...
This would be affected little by metric also...

B,3,17 Interview with John Gosselin

Mr. Gosselin is in the Right-of-Way Section for District 5. He negotiated part of the Right-of-Way procurement with the property owners after the appraisals were approved.

Q. How much metric work did you do on the job?

A. We converted the plans to English units so the property owners would have an understanding of them...I asked the property owners about the metric system and their basic reaction was that they didn't want to hear about it and just be talked to in English...With the plans in front of them they could understand the conversion from one to another...They feared that if conversion took place that they couldn't get replacement parts for appliances and farm equipment and this would cost them.. One guy thought the only reason the country was going metric was so the military could read captured maps...

Q. Do you think their attitude hindered your negotiations?

A. No...It would have had we not converted the plans prior to negotiations...There was no hostility just disinterest in the metric system...

Q. How long did it take to convert everything you needed?

A. It took me about 6 hrs. to convert and write the plan letters in dual dimensions...

Q. Do you have any feelings about the metric system?

A. Well, I'll join the property owners...I don't expect to be around when it finally goes thru...But as far as working with it I'll do the job...

Q. If everyone were educated to it do you feel it would be a simpler system?

A. With everything based on tens, I would say it would be easier...

Q. Did the plans have everything you needed to work with?

A. Yes...

Q. Was the price affected by the job being done in metric?

B,3,17 (Cont.)

B,3

A. No...the value is there regardless of whether it is done in metric or English...

Q. Were the property owners told what the metric measurements were?

A. Yes...and as long as they had the conversion in front of them they understood it...We also gave them a conversion table with wt. and measures on it...The plans we gave them were colored up and had all the metric dimensions on them...the conversion was put above this...The people were exposed to the metric system...

Q. Would you volunteer to work on another metric job?

A. Yes...In the job notes I have a summary of what all the people said...

B,3,18 Interview with S. G. Bell

Mr. Bell is in the Right-of-Way Section for District 5. He negotiated part of the Right-of-Way procurement with the property owners after the appraisals were approved.

Q. Before you talked to the people did you convert to English units?

A. We put the conversion right on the plans...

Q. What was their reaction when you discussed the metric system?

A. We gave them conversion tables, the dual dimensioned map, and asked if they'd like to be explained the system...their reactions were like "We couldn't care less", "I haven't got time", I won't be around when it goes through"...

Q. Did you have any trouble working with the plans?

A. No...not as long as I had the table there in front of me...

Q. Was there any time added to your work?

A. Only a little bit for conversion of units...I myself think its a good idea...why should the U.S. be the only country not on the metric system...

APPENDIX C

A Comprehensive Bibliography of Metrication

The following bibliography contains all the works, identified in our literature search, which deal with metrication, provided they were not listed in NASA's Information on the Metric System and Related Fields by E. Lange, L. Sokol and V. Antoine, Sixth Edition, Feb. 1, 1974. This bibliography is therefore complementary to NASA's. All items considered as pertinent to highway metrication from either of these two bibliographies were abstracted and included in the Annotated Bibliography (Appendix B).

- (1) "A.R.C. Reinforcement Data Sheet," A.R.C. Engineering Pty. Ltd., Australia, Dec., 1973.
- (2) "Aggregate," Metric Change Information Sheet, Metric Conversion Board, Oct. 26, 1972.
- (3) Alexander, F.D., "The Metric System -- Let's Emphasize Its Use in Mathematics," Arithmetic Teacher, Vol. 20, No. 5, pp. 395-396.
- (4) Astrop, A.W., "Metrication -- Springboard for Rationalization," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pg. 498.
- (5) "A34 Abingdon Bypass," Royal County of Berkshire, Berkshire, England, 1972?
- (6) "Australian-Made Metric Cars Now Being Planned," MCB Newsletter, Vol. 3, No. 6, April, 1974, p. 1.
- (7) Barr, A.W.C., "The Public Sector," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (8) Beer, S., "Question of Metric," Operational Research Quarterly I, Vol. 22, No. 5I, 1971, pg. 133.
- (9) Bellafio, I.J., "Metric Calculations Preferred," American Journal of Pharmaceutical Education, Vol. 32, No. N4, 1968.
- (10) Berryman, Jack, "Decimals Before Fractions," Mathematics in School, Vol. 1, No. 5, pp. 18-20.
- (11) Beyer, W.A., et. al., "Metrics in Biology, An Introduction," U.S. Government Report Number LA 4973, Los Alamos Scientific Lab., New Mexico, Aug., 1972.

- (12) Bolwell, A.J., "Jingle Dial Gives Metric Conversion," Design News, Vol. 28, No. 16, pp. 57.
- (13) Bonnel, G.E., "Asbestos Cement Products," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (14) Bourne, C.R., "The Problems of Conversion of Maps and Plans to the Metric System," presented at the Conference of Commonwealth Survey Officers, Paper No. 41, Tech. Paper No. 13, 1963.
- (15) "Brief History and Use of the English and Metric Systems of Measurement," Science Teacher, Vol. 36, No. 5, pp. 39-40.
- (16) "British Industry and the Metric System," PD5069, British Standards Institution, London, Oct., 1963
- (17) Brown, Duane C., "Advanced Methods for the Calibration of Metric Cameras", U.S. Government Report Number: AD-706-870, DBA Systems Inc., Melbourne, Florida, December, 1968.
- (18) Burditt, Chris, "Two-Pan Weighings," Two-Year College Mathematics Journal, Vol. 3, No. 2, pp. 80-81.
- (19) Burgess, H.J., "Timber in Construction," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (20) Butlerton, Meredith L., Metric 16, Moore Publishing Company, Durham, N.C., 1972.
- (21) Cady, Cullison, "We're Inching Up to the Meter," Highway User, July, 1973, pp. 16-19.
- (22) "Canada Prepares for Metric Conversion," Bank of Montreal Business Review, Jan., 1974, pp. 1-4.

- (23) "Cement," Metric Change Information Sheet, Oct. 19, 1972, p. 1.
- (24) "Cement and Concrete Association Report for the Year 1973," Cement and Concrete Association, London, 1974?
- (25) "The Change to Metric and Its Implications," Road Engineering Industry Standards Committee of the British Standards Institution, London?, January 1, 1969.
- (26) "Change to Metric in Commercial Road Transport," Metric Advisory Board, Wellington, New Zealand, Feb. 22, 1973.
- (27) "Change to Metric in Road Transport," Metric Advisory Board, Wellington, New Zealand, Nov. 1, 1972.
- (28) "The Change to the Metric System in the Construction Industry," British Standards Institution, London, date unknown.
- (29) Clarke, Michael, "Building Standards," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (30) "Clay Bricks," Metric Change Information Sheet, Metric Conversion Board, Oct. 19, 1972, p. 1.
- (31) "Coarse-Pitch or Fine-Pitch Metric Threads," Machinery and Production Engineering, Vol. 116, No. 299, 1970, pp. 457.
- (32) "Concrete Pipes," Metric Change Information Sheet, Metric Conversion Board, July 20, 1973, p. 1.
- (33) Connolly, J.V., "Using SI Metric Correctly," Industrial Lubrication and Tribology, Vol. 23, 1971, No. N4, pg. 137.

- (34) "Construction of Flexibly Jointed Concrete Pipelines," Technical Bulletin No. 1, The Concrete Pipe Association of Great Britain, Brenchly, England, 1974.
- (35) Conversion Factors and Conversion Tables, Metrication Board, Singapore, 1971.
- (36) "Conversion of Production Equipment to Metric Operation," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pp. 509.
- (37) Cook, J.F., "The Conversion of Goddard Range and Range Rate Teaching Data to Metric Units," U.S. Government Report Number: N70-37530, National Aeronautics and Space Administration, June, 1970.
- (38) "Correct SI Measuring Instruments," MPT6a, South African Bureau of Standards, Oct., 1972.
- (39) Cox, Philip L., Exploring Linear Measure.
- (40) Cox, Philip L., "Exploring Linear Measure, Teacher's Guide."
- (41) "Craftsmen's Pocket Handbook," Metrication in the Construction Industry, Great Britain Ministry of Public Building and Works, HMSO, London, 1971.
- (42) Cruickshank, H.J., "Metrication: Coming to the Point," Civil Engineering Public Works Review, Vol. 66, April, 1971, pp. 431-2.
- (43) Crutchley, G.I., "Thoughts on Metrication: Design and Construction of a Regional Sewerage and Sewage Disposal Scheme," Civil Engineering and Public Works Review, April, 1971, p. 433.
- (44) "Data Sheet: Hot Rolled Reinforcing Bars," GKN Limited, South Wales, date unknown.

- (45) Davies, C., "Composite Beam Design Charts in SI Units," Civil Engineering and Public Works Review, Vol. 67, No. 787, Feb. 1972, pp. 145-52.
- (46) "Decimalisation and Metrication -- How and When in Premix," Premix Concrete Limited, Oxford, England, June, 1970.
- (47) "Drill Sizes for ISO Metric Coarse Thread Series -- General Purposes," Metric Change Information Sheet, Feb. 27, 1974, pp. 1-2
- (48) "Dual Inch Metric Dials for Herbert Lathes," Machine-Tool Review, Vol. 59, No. 350, 1971, pg. 64.
- (49) Dunstone, Philip, "Change to Metric," Construction Specifier, Vol. 27, No. 1, Jan. 1974, pp. 26-33.
- (50) Dunstone, Phillip, "Quantity Surveying," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (51) "EE-AEI Kapak Metric Motors," Machinery and Production Engineering, Vol. 119, No. 306, 1971, pg 256.
- (52) Edwards, P.B., "Structural Engineering," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (53) Ellett, Alan S., "Building Contracting," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (54) England, C.B., "Adoption of Metric System in USA," Soil Science Society of America Proceedings, Vol. 37, No. 2, Mar./Apr., 1973, p. 337.
- (55) "Explanation of Dual (Inch/Metric) Dimensioning," Reprographic, Vol. 10, No. 1, 1972, pg. 19.

- (56) Falkell, Dutch, "Metric System Closing In," Roads and Streets, Vol. 116, No. 7, July, 1973, p. 111.
- (57) "Fearn's Metric Conversion Calculators," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pp. 526.
- (58) "Fenner Metric Range of V-Belt Drives," Machinery and Production Engineering, Vol. 118, No. N3, 1971, pp. 413.
- (59) Fineblum, Carol M., "Key Issues Concerning the Adoption of the Metric System and Implications for the Education of Exceptional Children."
- (60) "First Report on the Metric Changeover Timetable for the Engineering and Engineering Servicing Industries," Metric Advisory Board, Wellington, New Zealand, June 23, 1972.
- (61) Fisher, Ron, "Metric Is Here; So Let's Get On With It," Arithmetic Teacher, Vol. 20, No. 5, pp. 400-402.
- (62) Forrester, G.R. and Hunter, G.S., "Rockfill," Institution of Highway Engineers Journal, Vol. 18, No. 12, Dec., 1971, pp. 34-37.
- (63) Freeland, J.B., "Metrication and Farmer," Journal of the Royal Agricultural Society of England, Vol. 131, 1970, pg. 50.
- (64) "French Road Machinery Will Be Made (SI) in U.S.A.," American Metric Journal, July/Aug., 1974, p. 40.
- (65) Godfrey, A.H., The Australian Metric Manual, West Publishing, Sydney, 1971.
- (66) "Going Metric: Metrication in Britain," The Metrication Board, London, May, 1974.

- (67) Going Metric -- Progress in 1970, Metrication Board, HMSO, London, 1971.
- (68) Going Metric -- Progress in 1972, Metrication Board, HMSO, London, 1973.
- (69) "Going Metric: Retraining Design Staff," Metrication Board, London, date unknown.
- (70) "Going Metric: The International Metric System," Metrication Board, London, Jan., 1974.
- (71) "Going Metric: The Metric World," The Metrication Board, London, May, 1974.
- (72) Going Metric -- The Next Phase, Metrication Board, HMSO, London, 1974.
- (73) "Going Metric 12," Metrication Board Quarterly Bulletin, No. 12, July 26, 1974, p. 1-2.
- (74) Gossage, Stevenson M., "Going Metric in Canada," Canadian Institute of Chartered Accountants, No. 103, Sept., 1973, pp. 33-37.
- (75) "Government Will Hasten Slowly Over Metrication BL. Profit Hangs on Pay Productivity and Models," Engineer, Vol. 234, No. 6048, 1972.
- (76) Graham, M.J., "Metric Primer," Journal of the American Water Works Association, Vol. 65, No. 6, 1973, pg. 441.
- (77) Green, Victor E., "A Plea to Stop the Use of the Quintal as A Metric Weight Measure," Soil Science Society of America Proceedings, Vol. 33, No. 6, 1969, pp. 978-9.

- (78) Groner, Alex, Going Metric: An AMA Survey Report, American Management Association, New York, 1973.
- (79) "Guide to all CITB Metrication Re-training Aids," Construction Industry Training Board, London, June, 1973.
- (80) "A Guide to Structural Design of Pavements for New Roads," Road Research Lab Road Notes, Road Research Laboratory, London, 1970.
- (81) Hale, F.M., "Metrication of Speed Limit Signs," Traffic Engineering and Control, Vol. 11, No. 10, April, 1970.
- (82) Hall, F., "Progress in Metrication of Electric Motors," Electrical Review, Vol. 188, No. N7, 1971, pg. 232.
- (83) Harris, Raymond G., "Architecture -- Private Sector," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (84) Hawkins, Vincent J., "Teaching the Metric System as Part of Compulsory Conversion in The United States," Arithmetic Teacher, Vol. 20, No. 5, pp. 390-394.
- (85) Hector, A.M. and Barry, E., "Working Paper on Metric Conversion," Journal of Paint Technology, Vol. 45, No. 582, July, 1973.
- (86) "Highway Department Begins with Metric Signing Program," TSA Bulletin (Traffic Safety Association of Detroit), Vol. 31, No. 5, Aug.-Sept. 1973, p. 4.
- (87) "Highway Design -- Metrication," Roads and Road Construction, Vol. 46, Dec. 1968, pp. 380-383.
- (88) Hinnars, S., "Metric System and Feed Industry," Feedstuffs, Vol. 44, No. 19, 1972, pg. 32.

- (89) Hollingu, J., "Now is Time to Plan -- Converting Your Machine Shop to Metric," Metalworking Production, Vol. 113, No. N7, 1969, pp. 51.
- (90) Horsfiel, M., "Anomalies in Related Dimensions of Metric Face and Shell End Milling Cutters," Machinery and Production Engineering, Vol. 117, No. N3, 1970, pg. 1069.
- (91) Hosking, J.R., "Metric Test Sieves for Highway Engineering Purposes," Technical Note TN 460, Road Research Laboratory, Crowthorne, England, Nov., 1969 (unpublished).
- (92) Howgate, Ian, "Metrication -- Metric Screw Supplies Breaking the Vicious Circle," Electrical Review, Vol. 189, No. 10, Nov, 1971, pp. 340-1.
- (93) Humburger, E., "Introduction to CPMA Working Paper on Metric Conversion," Journal of Paint Technology, Vol. 45, No. 582, July, 1973.
- (94) "Hydraulic Calculations for Sewers and Surface Water Drains in Metric Terms," Technical Bulletin No. 4, Concrete Pipe Association of Great Britain, Brenchly, England, 1972.
- (95) "ISO Session, a World Going Metric," Journal Water Pollution Control Federation, Vol. 45, Oct. 1973, pp. 2062-4.
- (96) Immerzeel, George, and Wiederanders, Don, "Ideas," Arithmetic Teacher, Vol. 20, No. 4, pp. 280-287.
- (97) The Industrial Training Yearbook: 1972. A Comprehensive Guide for Training Officers and their Managements.

- (98) Isaev, B.M. and Burdun, G.D., "Practical Use of the SI units," Measurement Techniques, Vol. 8, Aug. 1970, pp. 1137-45.
- (99) Johnson, T.A., "Metrication Matters," Royal Institute of Chartered Surveyors, Dec. 1971.
- (100) Johnstone, H.A., "Metric Design at Westland Helicopters Ltd.," Machinery and Production Engineering, Vol. 120, No. 3100, April 12, 1972, pp. 501-5.
- (101) Joly, Roxee W., "Changing to the Metric System," NASSP Bulletin, Vol. 56, No. 367, pp. 347-359.
- (102) Josifek, C.W., "Metric System: Three Year's Experience Using it as a Standard," 24th National Plant Engineering and Maintenance Conference, Chicago, Ill., March 12-15, 1973.
- (103) "July 1 Was "M" Day for Australian Roads and Real Estate," Metric Reporter, Vol. 2, No. 14, p. 5.
- (104) Kroeze, Henry, "Training Your Work Force to Think Metric," American Metric Journal, Vol. 1, No. 1, Sept., 1973, pp. 23-5.
- (105) Lighthill, M.J., et.al., Metric Units in Primary Schools, The Royal Society, London, 1969.
- (106) Little, A.B., Speedy Metric Conversion Tables, N.S.W. Horwitz, North Sydney, 1971.
- (107) "Loads on Buried Concrete Pipe-Lines. Tables of Total Design Loads," Concrete Pipe Association, Road Research Laboratory, London, Sept. 1969.
- (108) "Lynester Standard Metric Covers and Plates," Machinery and Production Engineering, Vol. 118, No. N3, 1971, pg. 38.

- (109) McClory, Robert, "Legislation and the Metric Systems," Illinois Career Education Journal, Vol. 30, No. 3, pp. 9-11.
- (110) MacDonald, R.G., "Metal Windows," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (111) McKeone, D.H., "Changeover to Metric in a Technical College," Electrical Review, Vol. 188, No. NI, 1971, pg. 444.
- (112) Magee, K.L., "Metrication -- A Must", Agricultural Engineering, Vol. 51, No. NI, 1970, pg. 635.
- (113) "Main Roads Go Metric," Commissioner for Main Roads, New South Wales, Australia, 1974?
- (114) Malcolm, M.C.D., Introducing Metric: the Plain Man's Guide to Metrication, Kogan Page Ltd., London, 1972.
- (115) Marklew, J.J., "Producing First Asquith All-Metric Machine," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pg. 491.
- (116) Markstrom, Philip A., "IBM Goes Metric," Illinois Career Education Journal, Vol. 30, No. 3, pp. 14-16.
- (117) Martin, C.F., "Evaluation of Tracking Station Coordinates Obtained Using Metric Tracking Data," American Geophysical Union, National Fall Meeting, December 4-7, 1972.
- (118) Martin, P.L., "Building Services Design and Equipment," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.

- (119) Mateos, M., "Integration of British and Metric Systems," presented at a meeting for the American Society of Mechanical Engineerings, May, 1963.
- (120) "Materials in SI Units: Metric Data Sheet No. 4," EM&D, Vol. 11, No. 5, May, 1968, p. 773.
- (121) "Materials in SI Units: Metric Data Sheet No. 1," EM&D, Vol. 11, No. 1, Jan., 1968, p. 97.
- (122) "Materials in SI Units: Metric Data Sheet No. 2," EM&D, Vol. 11, No. 2, Feb., 1968, p. 241.
- (123) "Materials in SI Units: Metric Data Sheet No. 3," EM&D, Vol. 11, No. 3, Mar., 1968, p. 415.
- (124) "Materials in SI Units: Metric Data Sheet No. 5," EM&D, Vol. 11, No. 6, June, 1968, p. 963.
- (125) "Materials in SI Units: Metric Data Sheet No. 6," EM&D, Vol. 11, No. 8, Aug. 1968, p. 1269.
- (126) "Materials in SI Units: Metric Data Sheet No. 7," EM&D, Vol. 11, No. 10, Oct., 1968.
- (127) Maxwell, D.J., "Apparatus Review," Mathematics in School, Vol. 1, No. 1, pp. 33.
- (128) "Metric America," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pg. 497.
- (129) "Metric Body Temperature," Annals of Internal Medicine, Vol. 76, No. 3, 1972.
- (130) "Metric Conversion Bills," American Enterprise Institute for Public Policy Research, Washington, D.C., March, 1974.

- (131) "Metric Conversion Board Recommended Application of SI Units in the Land and Surveying Sector," Land and Surveying Sector Committee, Metric Conversion Board, St. Leonards, Australia, Mar. 28, 1972.
- (132) "Metric Conversion for Building and Construction: Design Notes," Metric Conversion Board, St. Leonards, Australia, June, 1973.
- (133) "Metric Conversion in Building and Construction: Design Notes," Metric Conversion Board, St. Leonards, Australia, Sept., 1972.
- (134) "Metric Conversion Information Brochure," Metric Conversion Board, Road Transport Sector, Transport and Communications Advisory Committee, St. Leonards, Australia, date unknown.
- (135) "Metric Conversion is on the Way," Men and Steel, Vol. 27, No. 2, Summer, 1974.
- (136) "Metric Conversion Manual for Engineering Establishments," Metric Conversion Board, St. Leonards, Australia, April, 1974.
- (137) "Metric Conversion Tables," British Quarrying and Slag Federation Ltd., London?, date unknown.
- (138) "Metric Conversion Tables," Construction Industry Training Board, London, date unknown.
- (139) Metric Conversion Tables; Acres -Hectares, Feet-Metres, Links-Metres, Acres-Square Metres, Square Feet- Square Metres, Dept. of Lands and Surveys, Western Australia, Perth, 1972.
- (140) Metric Conversion Tables for Liquid Capacities, International Financial Publishing Co., Manchester, 1970.

- (141) "Metric Identification," Metric Memo, No. M1, Aug. 19, 1971, pp. 1-3.
- (142) "Metric in Feeds on a Universal Grinder," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pg. 505.
- (143) "Metric Information for Building and Construction Workers," Metric Conversion Board, St. Leonards, Australia, Oct. 1973.
- (144) "Metric Information for Building Tradesmen," Metric Conversion Board, St. Leonards, Australia, date unknown.
- (145) "Metric Information: Kitchen Metrics," Metric Conversion Board, St. Leonards, Australia, date unknown.
- (146) "Metric Information: Timber and Forestry," Metric Conversion Board, St. Leonards, Australia, July, 1973.
- (147) "Metric Kitchens a Little Nearer," Electrical Review, Vol. 185, No. N23, 1969, pg. 839.
- (148) "Metric Measurement," Medical Journal of Australia, Vol. 1, No. 21, 1972, pg. 1110.
- (149) "Metric Motoring," Metrication Council, Salisbury, Rhodesia, 1972?
- (150) "Metric Practice in the Drawing Office," Metric Memo, No. M17, May 31, 1973, pp. 1-5.
- (151) "Metric 71," Amey Gravel Limited, Oxford, England, Oct., 1970.

- (152) "Metric Sine Bar Constants," Machinery and Production Engineering, Vol. 119, No. 3071, Sept. 22, 1971, pp. 410-4.
- (153) "Metric System," Forestry Chronicle, Vol. 49, No. 3, 1973, pg. 122.
- (154) "Metric System," Journal of Bone and Joint Surgery, Vol. A53, No. 8, 1971, pg. 1664.
- (155) "The Metric System and Its Relationship to Road Transport," Road Transport Division, Ministry of Transport, Wellington, New Zealand, 1972.
- (156) "Metric System: Conversion Factors," Journal of Bone and Joint Surgery, Vol. 54A, No. 2, 1972, pp. 429.
- (157) "Metric System: Conversion Factors," Journal of Bone and Joint Surgery, Vol. 52A, No. 3, 1972, pp. 684.
- (158) "Metric System -- Units and Conversion Factors," Journal of Bone and Joint Surgery, Vol. 52A, No. 4, 1970, pp. 842.
- (159) "Metric System -- Units and Conversion Factors," Journal of Bone and Joint Surgery, Vol. 53A, No. 4, 1971, pp. 821.
- (160) "Metric Tolerances for Diecasting," Engineering Materials and Design, Vol. 13, No. N1, 1970, pp. 1275.
- (161) "Metric Warehouses -- Progress Report," Mechanical Handling, Vol. 60, No. 1, 1973, pg. 17.
- (162) "The Metric World," South African Metrication News, No. 5, May, 1972, p. 3.

- (163) "Metrication: A Guide for Procedures of Packaged Goods," Consumer Research Report No. 4, ED072306 72.
- (164) "Metrication at Work Training Manual," Local Government Training Board, London, 1971.
- (165) Metrication -- Government Supports Metrication in Face of Back Bench Opposition," Electrical Review, Vol. 187, No. NI, 1970, pg. 666.
- (166) "Metrication in the Construction Industry," Great Britain Ministry of Public Building and Works, Her Majesty's Stationery Office, London, 1970.
- (167) Metrication in the States, The Council of State Governments, Lexington, Kentucky, 1970.
- (168) "Metrication Kit for Drawing Boards," Machinery and Production Engineering, Vol. 120, No. 3103, May 3, 1972, p. 633.
- (169) "Metrication of Concrete Pipes and Revision of Strength Classes," Concrete Pipe Association, London?, 1969.
- (170) "Metrication of Land Measurement and Maps," Metric Memo, No. M15, May 6, 1974, pp. 1-3.
- (171) "The Metrication of the Diameters of Pipes Produced Primarily for the Conveyance of Fluids and Used in the Construction Industry," British Standards Institution, London, July, 1970.
- (172) "Metrication of the Road Construction Industry," M7, South African Bureau of Standards, Pretoria, South Africa, July, 1970.
- (173) "Metrication Review," Ministry of Technology, London, June, 1966.

- (174) "Metrication Seen as No Major Threat to Nations Tool and Die Industry," Metal Stamping, Vol. 5, No. N8, 1971, Pg. 23.
- (175) "Metrication Tables," Local Government Training Board, London, 1971.
- (176) "Metrication: The Legislative Position," Metric Memo, No. M11, Dec. 3, 1973.
- (177) Mettler, Albert J., "Survey of Selected European Standards and Methods," Canadian Metric Association, Fonthill, Ontario, Oct., 1969.
- (178) Michael, Harold, L., "Final Report of Committee on Metric Usage," Institute of Traffic Engineers, Washington, D.C., Oct. 9, 1970.
- (179) "Mixed Feelings About Progress of Metrication," Electrical Review, Vol. 185, No. N23, 1969, pp. 840.
- (180) Moncrieff, D.S., "The Role of the R.R.L. in Metrication," Road Research Laboratory, Ministry of Transport, Crowthorne, August, 1967, (unpublished).
- (181) "Moore Reed Pulse -- Generator with Metric and Imperial Counts," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pg. 523.
- (182) Morse, T., "Metric Mix-Up a Danger to Motorway Bridges," Engineer, Vol. 236, May 10, 1973, p. 7.
- (183) Muller, L.L., "Metric Conversion in Dairy Industry," Australian Journal of Dairy Technology, Vol. 27, No. 3, 1972, pg. 72.
- (184) Muller, L.L., "Metric Conversion -- Some Practical Aspects for Dairy Factories," Australian Journal of Dairy Technology, Vol. 27, No. 4, 1972, pg. 113.

- (196) Parks, R.W., "Precast Concrete," presented at the Metrication Board Conference on building and civil engineering, London, July, 1971.
- (197) Parr, F.E., "An Investigation into the Availability of Engineering Design Data in SI Units," Standardization, No. 90, Sept., 1972, pp. 2-4.
- (198) "The Pascal as Unit of Pressure and Stress," MP14, South African Bureau of Standards, Jan., 1972.
- (199) Peach, J., "Implication of Metrication in Building Services Industry: Modification to International System of Units and Practical Units," Journal of the Institution of Heating and Ventilation Engineers, Vol. 39, No. 8, 1971, pg. 112.
- (200) Pidgeon, Geoffrey, "Builders Merchants," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (201) "Planned Use of Metric Equivalents Dropped by Group," Engineering News-Record, Vol 193, No. 10, Aug. 29, 1974, p. 13.
- (202) Pokorney, Joseph L., "Metric Conversion," Illinois Career Education Journal, Vol. 30, No. 3, pp. 2-8.
- (203) Pokorney, Joseph L., "Metric Conversion: The Training Colossus of the Seventies," Training and Development Journal, Vol. 27, No. 6, pp. 3-8.
- (204) "Precision Conversion of Dimensions," MPT31, South African Bureau of Standards, Aug., 1972.
- (205) "Progress in Changing to the Metric System," Concrete, Vol. 3, No. 2, Feb., 1969, p. 58.

- (206) "A Progress Report," American National Metric Council, Washington, D.C., April, 1974.
- (207) "Progress Report," Metric Advisory Board, Wellington, New Zealand, 1973.
- (208) "Progress Report (4)," Metric Notes, No. 27, Aug., 1973, pp. 1-4.
- (209) "Publicity Planned for the July 1974 Roads Switch," MCB Newsletter, Vol. 2, No. 12, Oct., 1973, p. 1.
- (210) Pulham, C.J., "Textile Metrication -- Practical Approach," Textile Institute and Industry, Vol. 11, No. 3, 1973, pg. 72.
- (211) "Putting Metrication into Effect -- Information and Liason Needed," EM&D, Vol. 11, No. 8, 1968, p. 1247.
- (212) Quantities, Units, and Symbols, ERIC Number ED059879 71.
- (213) "RTAC's Proposed Plan for National Metric Conversion of Road Systems," RTAC, ?, Canada, 1973?
- (214) "Rainfall, River Height, Wave Height, Snow Depth, Go Metric 1 January 1974," Department of Science, Bureau of Meteorology, ?, Australia, 1973?
- (215) Ralpho, Lincoln, "Training for Metrication," Industrial Training International, Vol. 6, No. 12, pp. 360-361.
- (216) Ramsay, D.C. and G.W. Taylor, Engineering in SI Units, W. & R. Chambers, Ltd., London, 1971.
- (217) "Recommendations on the Use of Metric Units in Engineering Calculations," E.E.U.A. Document No. 43D, Engineering Equipment Users Association, London, 1972.

- (218) "Recommended Metric Conversion Program for Land & Surveying," Metric Conversion Board, St. Leonards, Australia, June, 1972.
- (219) "Recommended Metric Conversion Timetable for the Government Construction Sector," Metric Conversion Board, June, 1972.
- (220) "Report and Accounts 1973," British Quarrying and Slag Federation, London, England, May, 1974.
- (221) "Report of Working Party on Weighing Machines," Metric Memo, No. M3, Sept. 9, 1971, pp. 1-4.
- (222) "Recommended Metric Cutting Speeds for Bandsawing," Machinery and Production Engineering, Vol. 118, No. N3, 1971, pg. 761.
- (223) Reed, G., "Service Talk -- Metrication," Refrigeration and Air Conditioning, Vol. '73, No. N8, 1970, p. 51.
- (224) "Reinforcing Material," Metric Change Information Sheet, Metric Conversion Board, Oct. 23, 1972, p. 1.
- (225) SMEAC Newsletter, Mathematics Education, Vol. 5, No. 1.
- (226) "Scale Rules," MPT 11a, South African Bureau of Standards, Nov. 1971.
- (227) "Scale Rules," Metric Change Information Sheet, Metric Conversion Board, Sept. 17, 1973, p. 1.
- (228) Scherrooman, James A., "Asphalt Pavement by the Cubic Meter," Asphalt, Vol. 26, No. 1, Jan., 1974, p. 12.
- (229) Sellers, Robert C., The Executive's Guide to Planning Transition to the Metric -- SI System, R.C. Sellers and Associates, Floral Park, New York, 1973.

- (230) Shaw, R.W., "Going Metric -- Going Decimal," Mathematics in School, Vol. 1, No. 1, pp. 23-24.
- (231) "Sheet and Strip -- Wrought Ferrous and Non-Ferrous," Metric Change Information Sheet, Mar. 12, 1974, p. 1.
- (232) Sheffield Susan G., "The Metric Stick," Science and Children, Vol. 10, No. 6, pp. 22-24.
- (233) Shostin, N.A., "Mendeleev Di and Metric System of Measures," Measurement Techniques, Vol. 1, No. 4, 1968, pg. 429.
- (234) Sibthorp, Thomas, "Joinery," presented at the Metrication Board Conference on Building and Civil Engineering, London, July, 1971.
- (235) Sliwa, Jan, "Architecture -- R.I.B.A.," presented at the Metrication Board Conference on Building and Civil Engineering.
- (236) Small, W., "Some References on Metric Information With Charts on All You Need to Know About Metric; Metric Conversion Factors," U.S. Government Report Number Com-74-50182, National Bureau of Standards, Washington, D.C., December 1973.
- (237) "Smiths Calculators: Metric Conversion Rules and Calculators," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pp. 526.
- (238) "Smiths Industries Metric Hydraulic Hand Pumps," Machinery and Production Engineering, Vol. 119, No. 307, 1971, pg. 464.
- (239) Somerville, G. and Tiller, R.M., "Standard Bridge Beams for Spans from 7m to 36m," Cement and Concrete Association, London, Nov., 1970.

- (240) "Special Steel Engineering Limits & Fits," British Steel Corp., U.S. Govt. Report Number PB-214 228/9. October, 1972.
- (241) Spence, William, "Overhead Transparency Master: Metric's the Rule, Not the Exception," Industrial Education, Vol. 62, No. 3, pp. 8-10.
- (242) "Spheric Metric Size Plug Gauges," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pg. 500.
- (243) Stephan, Harold O, "Statement on Metric Conversion," presented before the subcommittee on science, research and development of the House committee on science and astronautics, Mar. 21, 1973.
- (244) Sterling, D., Engineering Drawing and Materials 2, second edition, International Textbook Company Ltd., London, 1971.
- (245) "Stick Type - 20 Metric Lathes," Machinery and Production Engineering, Vol. 120, No. 310, 1972, pg. 524.
- (246) "A Study to Develop an Optimum Metric Fastener System," Machinery and Production Engineering, Vol. 120, No. 3100, April 12, 1972, pp. 506-8.
- (247) Suydam, Marilyn N., SMEAC Newsletter, Mathematics Education, Vol. 5, No. 2.
- (248) Swanson, C.A., "Metric Measurement Is A Standard," American National Standards Institute, New York, Feb., 1974.
- (249) "Tap Drill Sizes for Metric Taps 2," American Machinist, Vol. 118, No. 2, 1974, pp. 93.

- (250) "Thumbs down on Metric," New Engineer, Vol. 3, No. 6 June, 1974, p. 20.
- (251) Tunnel Cement Ltd., communication to users, London, Oct. 26, 1970
- (252) "Two Landmark Science Bills Pass Senate," Science News, Vol. 102, No. 9, p. 132.
- (253) Tye, J.E., "The Brick Industry," presented at the Metrication Board Conference on Building and Civil Engineering.
- (254) "U.S and Metric System," Metallurgia 1, Vol. 82, No. N4, 1970, pg. 165.
- (255) Ullman, J.R., "Metric Timer Case Shapes Design Options," Design News, Vol. 29, No. 6, 1974, p. 93.
- (256) "Units for Use in Design and Construction," Metric Notes, No. 18/19, Nov./Dec., 1972, pp. 2-14.
- (257) "The Use of the Comma As Decimal Indicator in Practice," MP9, South African Bureau of Standards, Dec., 1971.
- (258) Vanderhoist, R.L., "Metrication and Infant Formulas," Journal of Pediatrics, Vol. 82, No. 1, 1973, p. 163.
- (259) Varshneya, J.K., Metric Guide for Civil Engineers and Architects, 2nd ed., Metric Publications, Aligrah, India, 1964.
- (260) Vervoot, Gerardus, "Inching Our Way Towards the Metric System," Mathematics Teacher, Vol. 66, No. 4, pp. 297-302.
- (261) Vincent, A.B., "Metrication -- Start Learning Now," Forest Chio, Vol. 47, No. 5, 1971, pg. 249.

- (262) Vincent, R.H., "Civil Engineering Contracting," presented at the Metrication Board conference on building and civil engineering, London, July, 1971.
- (263) Wandmacher, Cornelius, "Science in Engineering Education," Journal of Engineering Education, Vol. 61, No. 7, pp. 827-830.
- (264) Warren, J.W., Metric Change in the Building Industry, New Zealand Metric Advisory Board, Wellington, New Zealand, 1973.
- (265) "Weightpieces for Testing Apparatus," MP13, South African Bureau of Standards, June, 1971.
- (266) Wellman, F., Avery, M.F., "Spell Out Your Metrication Plan," Metalworking Production, Vol. 114, No. N2, 1970, pg. 40.
- (267) "What It Will Cost to Go Metric," American School Board Journal, Vol. 160, No. 7, pp. 25-26.
- (268) Wellman, F. and M. Avery, "Training Your People to Work in Metric Units," Metalworking Production, Vol. 114, No. 31, 1970, p. 27.
- (269) Wood, Eleanor, "Future Shock -- Meters, Liters, Grams," California Business and Transportation Magazine, Vol. 2, No. 1, Jan./Feb., 1974.
- (270) "Work Cards," Mathematics in School, Vol. 1, No.1, pp. 19-20.
- (271) Working in Metric for Quantity Surveying, National Building Agency, London, 1970.
- (272) Wynn, A.H.A., "The Adoption of the Metric System in the United Kingdom," Chemistry and Industry, No. 44, Nov. 2, 1968, pp. 1512-6.

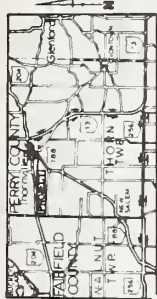
- (273) "Years Experience of Metrication by Cable Manufacturers and Users," Electrical Review, Vol. 188, No. NI, 1971, pg. 11.
- (274) Zhuraule, N.M., "Conversion of Thread Gauges to a Metric ISO Thread," Measurement Techniques I, Vol. 1970, No. N7, 1970, p. 982.

APPENDIX D

Selected Plan Sheets From Metric
Project No. 3 (PER-188-03.84)

STATE OF OHIO
 DEPARTMENT OF TRANSPORTATION

PER-188 - 3.84 - 3.84 (6.18 km)



DESIGN DESIGNATION
 CURRENT A.D.T. (1974) 1204
 1994 A.D.T. 2094
 D (Directional Distribution) 50-50
 T (Per Cent of B & C Trucks) 5%
 V (Design Speed) 80 km/h

CONVENTIONAL SIGNS

Corporation Line _____ Right of Way (only) _____ RW
 Fence Line (existing) _____ Existing Right of Way _____
 Center Line _____ 20' _____ (in existing fence) _____
 Trees _____ mm. Bush _____
 Utility Poles: Telephone ϕ , Power ϕ , Light ϕ _____
 Construction Limits _____

INDEX OF SHEETS

Title Sheet	1
Schematic Layout	2
Typical Section	3
General Notes & Calculations	4 & 4-A
Construction Drawings	5-13
Superlevation Table & Typical Section Drives	14
General Summary	15
Plan and Profile	16-20
Cross Sections	21-30
Structure 6 meter Span and Under	31-32
Right of Way	33-38

LINE DATA

Begin Project	Station 13+90
End Project	Station 19+80
Gross Length of Project	590 m
Begin Work	Station 13+60
End Work	Station 20+45.0
Gross Length of Work	685 m

Net Length Project 590 m or 0.590 km.
 Net Length Work 685 m or 0.685 km.

VILLAGE OF THORNVILLE
 THORN TOWNSHIP
 PERRY COUNTY

ALL ELEVATIONS AND MEASUREMENTS ARE
 IN METRIC UNITS
 UNLESS OTHERWISE SHOWN



LOCATION MAP

SCALE OF KILOMETERS

Portion to be improved
 State Route
 Other Roads

SCALES

Plan	0m 4m 8m 12m 16m 20m
Profile - Horizontal	0m 4m 8m 12m 16m 20m
Profile - Vertical	0m 1m 2m 3m 4m 5m
Cross Sections - Hor & Vert	0m 1m 2m 3m 4m

1973 SPECIFICATIONS, AMENDED

The standard specifications of the State of Ohio, Department of Transportation, including changes listed in the proposed and approved this improvement.

The right of way for this improvement will be provided by the State. I hereby approve these plans and declare that the making of this improvement will require the closing of traffic of the highway and that detours will be provided as indicated on the plans.

Approved _____
 Date 2-2-82 District Deputy Director of Transportation
 Approved _____
 Date 2-2-82 Engineer, Bureau of Highways
 Approved _____
 Date 2-2-82 Engineer, Bureau of Roadway Design
 Approved _____
 Date 2-2-82 Assistant Deputy Director for Highway Design
 Approved _____
 Date _____ Assistant Deputy Director for Road Estate
 Approved _____
 Date 2-2-82 Assistant Deputy Director for Program Development
 Approved _____
 Date _____ Chief Engineer, Division of Highways
 Approved _____
 Date 2-2-82 Deputy Director, Division of Highways
 Approved _____
 Date 1-12-82 Assistant Director, Department of Transportation
 Approved _____
 Date 2-2-82 Deputy Director, Department of Transportation

SUPERVISOR
 SIGNATURE
 10/25
 6/25/82

Figure 2. Title Sheet

100

CALCULATIONS

559 AGRICULTURAL LIMING
(Seeding) 20207 m² × 50 kg / 100 m² × 1 tonne / 1102 kg = 9.17 Tonne

TRAFFIC:

Two way through traffic shall be maintained until April 1, 1975, after which the detour may be put into effect

The following estimated quantities have been provided for maintaining traffic

- | | |
|---|-----------------|
| Item 410 Traffic Compacted Surface, Type A or B | 50 Cubic meters |
| Item 410 Traffic Compacted Surface, Type C | 50 Cubic meters |
| Item 616 Calcium Chloride | 1 Tonne |
| Item 616 Water | 20 Cubic meters |

ITEM 203 EMBANKMENT, USING
GRANULAR MATERIAL OR ROCK AS
PER PLAN:

Material furnished for this item shall be as defined in 303.02 (except that at least 95 per cent by weight of the grains or particles shall be retained on a No. 200 sieve), in the area between station 15-20 and 15-80 this material may be placed by the method of dumping surface water is present at the bottom of the excavation and the rate of fill placement shall be 4 meters in height and the rate of fill placement shall be not less than 1 meter per week for any fill placed above elevation 289 meters.

Where end dumping is permitted, normal clearing and grubbing shall be performed but the requirements of 201.04 for scraping shall be waived.

Payment for this item shall be under 203 Embankment, Using Granular Material or Rock, As Per Plan.

Figure 4 (Continued). General Notes

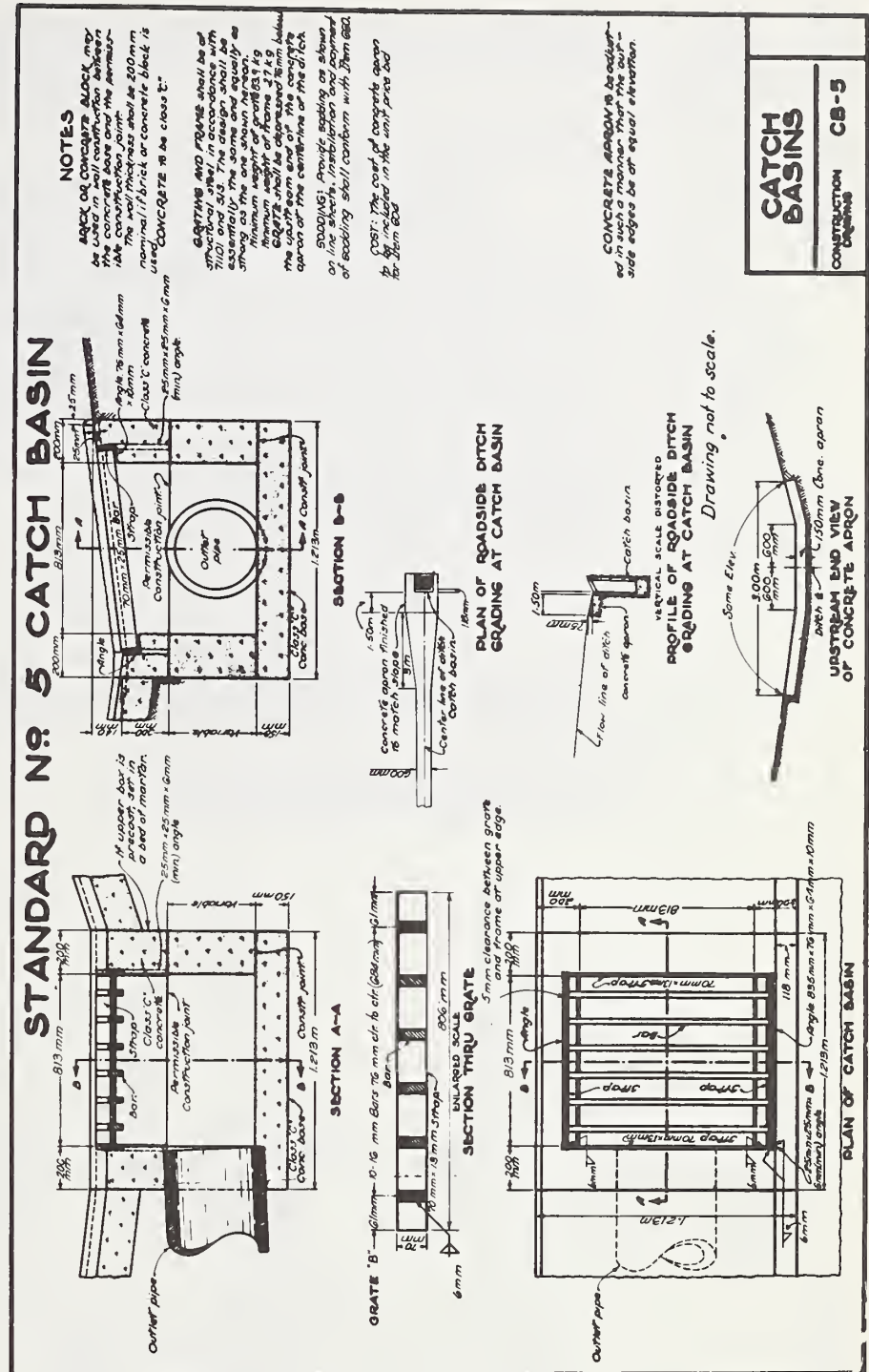


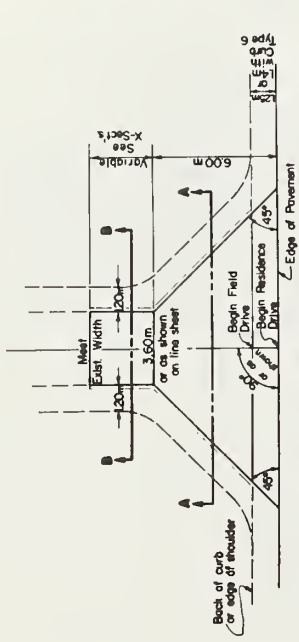
Figure 5. Catch Basins Standard Drawing

SUPERELEVATION TABLES

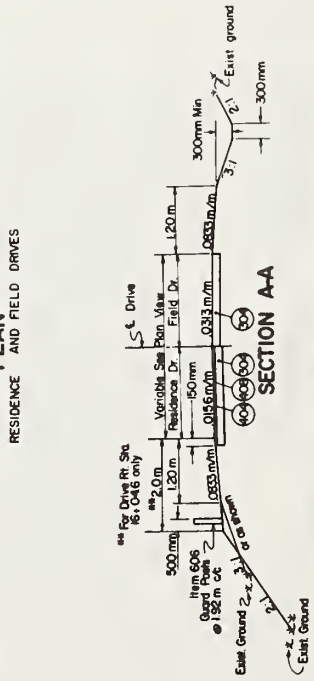
PC:19+80.935 D ₁ = 15° Rate of Super=0.2222 m/m		PT:20+31.585	
PC:19+80.029 D ₂ = 18.200° Rate of Super=0.2222 m/m		PT:20+31.585	
Dist from to f Meters	Elev L1 Edge Pavt	Profile Grade Elev	Station
0.000	302.059	303.151	18.12
0.050	302.558	303.054	1.36
0.231	302.931	302.967	1.40
0.285	302.895	302.915	1.44
0.315	302.865	302.895	1.52
0.360	302.830	302.860	1.55
0.404	302.804	302.834	1.56
0.427	302.787	302.813	1.60
0.460	302.760	302.787	1.64
0.500	302.700	302.716	1.76
0.533	301.933	301.989	1.80
0.561	301.651	301.717	1.85
0.583	301.313	301.379	1.86
0.624	301.268	301.324	1.90
0.656	301.056	301.112	1.04
0.680	300.980	300.980	1.08
0.700	300.900	300.900	1.16
0.720	300.820	300.820	1.20
0.740	300.620	300.620	2.20
0.755	300.535	300.532	2.24
0.780	300.460	300.436	1.28
0.816	300.316	300.275	1.32
0.848	300.148	300.117	1.36
0.898	300.008	300.044	1.40
0.946	300.046	300.072	1.48
0.980	300.080	300.095	1.48
1.000	300.000	300.035	1.48
1.020	300.020	300.035	1.52
1.048	300.048	300.064	1.60
1.080	300.080	300.094	1.64
1.100	300.000	300.055	1.68
1.120	300.020	300.076	1.72
1.140	300.040	300.096	1.72
1.160	300.060	300.116	1.72
1.180	300.080	300.136	1.72
1.200	300.100	300.156	1.72
1.220	300.120	300.176	1.72
1.240	300.140	300.196	1.72
1.260	300.160	300.216	1.72
1.280	300.180	300.236	1.72
1.300	300.200	300.256	1.72
1.320	300.220	300.276	1.72
1.340	300.240	300.296	1.72
1.360	300.260	300.316	1.72
1.380	300.280	300.336	1.72
1.400	300.300	300.356	1.72
1.420	300.320	300.376	1.72
1.440	300.340	300.396	1.72
1.460	300.360	300.416	1.72
1.480	300.380	300.436	1.72
1.500	300.400	300.456	1.72
1.520	300.420	300.476	1.72
1.540	300.440	300.496	1.72
1.560	300.460	300.516	1.72
1.580	300.480	300.536	1.72
1.600	300.500	300.556	1.72
1.620	300.520	300.576	1.72
1.640	300.540	300.596	1.72
1.660	300.560	300.616	1.72
1.680	300.580	300.636	1.72
1.700	300.600	300.656	1.72
1.720	300.620	300.676	1.72
1.740	300.640	300.696	1.72
1.760	300.660	300.716	1.72
1.780	300.680	300.736	1.72
1.800	300.700	300.756	1.72
1.820	300.720	300.776	1.72
1.840	300.740	300.796	1.72
1.860	300.760	300.816	1.72
1.880	300.780	300.836	1.72
1.900	300.800	300.856	1.72
1.920	300.820	300.876	1.72
1.940	300.840	300.896	1.72
1.960	300.860	300.916	1.72
1.980	300.880	300.936	1.72
2.000	300.900	300.956	1.72
2.020	300.920	300.976	1.72
2.040	300.940	300.996	1.72
2.060	300.960	301.016	1.72
2.080	300.980	301.036	1.72
2.100	301.000	301.056	1.72
2.120	301.020	301.076	1.72
2.140	301.040	301.096	1.72
2.160	301.060	301.116	1.72
2.180	301.080	301.136	1.72
2.200	301.100	301.156	1.72
2.220	301.120	301.176	1.72
2.240	301.140	301.196	1.72
2.260	301.160	301.216	1.72
2.280	301.180	301.236	1.72
2.300	301.200	301.256	1.72
2.320	301.220	301.276	1.72
2.340	301.240	301.296	1.72
2.360	301.260	301.316	1.72
2.380	301.280	301.336	1.72
2.400	301.300	301.356	1.72
2.420	301.320	301.376	1.72
2.440	301.340	301.396	1.72
2.460	301.360	301.416	1.72
2.480	301.380	301.436	1.72
2.500	301.400	301.456	1.72
2.520	301.420	301.476	1.72
2.540	301.440	301.496	1.72
2.560	301.460	301.516	1.72
2.580	301.480	301.536	1.72
2.600	301.500	301.556	1.72
2.620	301.520	301.576	1.72
2.640	301.540	301.596	1.72
2.660	301.560	301.616	1.72
2.680	301.580	301.636	1.72
2.700	301.600	301.656	1.72
2.720	301.620	301.676	1.72
2.740	301.640	301.696	1.72
2.760	301.660	301.716	1.72
2.780	301.680	301.736	1.72
2.800	301.700	301.756	1.72
2.820	301.720	301.776	1.72
2.840	301.740	301.796	1.72
2.860	301.760	301.816	1.72
2.880	301.780	301.836	1.72
2.900	301.800	301.856	1.72
2.920	301.820	301.876	1.72
2.940	301.840	301.896	1.72
2.960	301.860	301.916	1.72
2.980	301.880	301.936	1.72
3.000	301.900	301.956	1.72
3.020	301.920	301.976	1.72
3.040	301.940	301.996	1.72
3.060	301.960	302.016	1.72
3.080	301.980	302.036	1.72
3.100	302.000	302.056	1.72
3.120	302.020	302.076	1.72
3.140	302.040	302.096	1.72
3.160	302.060	302.116	1.72
3.180	302.080	302.136	1.72
3.200	302.100	302.156	1.72
3.220	302.120	302.176	1.72
3.240	302.140	302.196	1.72
3.260	302.160	302.216	1.72
3.280	302.180	302.236	1.72
3.300	302.200	302.256	1.72
3.320	302.220	302.276	1.72
3.340	302.240	302.296	1.72
3.360	302.260	302.316	1.72
3.380	302.280	302.336	1.72
3.400	302.300	302.356	1.72
3.420	302.320	302.376	1.72
3.440	302.340	302.396	1.72
3.460	302.360	302.416	1.72
3.480	302.380	302.436	1.72
3.500	302.400	302.456	1.72
3.520	302.420	302.476	1.72
3.540	302.440	302.496	1.72
3.560	302.460	302.516	1.72
3.580	302.480	302.536	1.72
3.600	302.500	302.556	1.72
3.620	302.520	302.576	1.72
3.640	302.540	302.596	1.72
3.660	302.560	302.616	1.72
3.680	302.580	302.636	1.72
3.700	302.600	302.656	1.72
3.720	302.620	302.676	1.72
3.740	302.640	302.696	1.72
3.760	302.660	302.716	1.72
3.780	302.680	302.736	1.72
3.800	302.700	302.756	1.72
3.820	302.720	302.776	1.72
3.840	302.740	302.796	1.72
3.860	302.760	302.816	1.72
3.880	302.780	302.836	1.72
3.900	302.800	302.856	1.72
3.920	302.820	302.876	1.72
3.940	302.840	302.896	1.72
3.960	302.860	302.916	1.72
3.980	302.880	302.936	1.72
4.000	302.900	302.956	1.72
4.020	302.920	302.976	1.72
4.040	302.940	302.996	1.72
4.060	302.960	303.016	1.72
4.080	302.980	303.036	1.72
4.100	303.000	303.056	1.72
4.120	303.020	303.076	1.72
4.140	303.040	303.096	1.72
4.160	303.060	303.116	1.72
4.180	303.080	303.136	1.72
4.200	303.100	303.156	1.72
4.220	303.120	303.176	1.72
4.240	303.140	303.196	1.72
4.260	303.160	303.216	1.72
4.280	303.180	303.236	1.72
4.300	303.200	303.256	1.72
4.320	303.220	303.276	1.72
4.340	303.240	303.296	1.72
4.360	303.260	303.316	1.72
4.380	303.280	303.336	1.72
4.400	303.300	303.356	1.72
4.420	303.320	303.376	1.72
4.440	303.340	303.396	1.72
4.460	303.360	303.416	1.72
4.480	303.380	303.436	1.72
4.500	303.400	303.456	1.72
4.520	303.420	303.476	1.72
4.540	303.440	303.496	1.72
4.560	303.460	303.516	1.72
4.580	303.480	303.536	1.72
4.600	303.500	303.556	1.72
4.620	303.520	303.576	1.72
4.640	303.540	303.596	1.72
4.660	303.560	303.616	1.72
4.680	303.580	303.636	1.72
4.700	303.600	303.656	1.72
4.720	303.620	303.676	1.72
4.740	303.640	303.696	1.72
4.760	303.660	303.716	1.72
4.780	303.680	303.736	1.72
4.800	303.700	303.756	1.72
4.820	303.720	303.776	1.72
4.840	303.740	303.796	1.72
4.860	303.760	303.816	1.72
4.880	303.780	303.836	1.72
4.900	303.800	303.856	1.72
4.920	303.820	303.876	1.72
4.940	303.840	303.896	1.72
4.960	303.860	303.916	1.72
4.980	303.880	303.936	1.72
5.000	303.900	303.956	1.72
5.020	303.920	303.976	1.72
5.040	303.940	303.996	1.72
5.060	303.960	304.016	1.72
5.080	303.980	304.036	1.72
5.100	304.000	304.056	1.72
5.120	304.020	304.076	1.72
5.140	304.040	304.096	1.72
5.160	304.060	304.116	1.72
5.180	304.080	304.136	1.72
5.200	304.100	304.156	1.72
5.220	304.120	304.176	1.72
5.240	304.140	304.196	1.72
5.260	304.160	304.216	1.72
5.280	304.180	304.236	1.72
5.300	304.200	304.256	1.72
5.320	304.220	304.276	1.72
5.340	304.240	304.296	1.72
5.360	304.260	304.316	1.72
5.380	304.280	304.336	1.72
5.400	304.300	304.356	1.72
5.420	304.320	304.376	1.72
5.440	304.340	304.396	1.72
5.460	304.360	304.416	1.72
5.480	304.380	304.436	1.72
5.500	304.400	304.456	1.72
5.520	304.420	304.476	1.72
5.540	304.440	304.496	1.72
5.560	304.460	304.516	1.72
5.580	304.480	304.536	1.72
5.600	304.500	304.556	1.72
5.620	304.520	304.576	1.72
5.640	304.540	304.596	1.72
5.660	304.560	304.616	1.72
5.6			

[illegible]

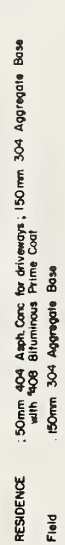
TYPICAL SECTION DRIVES



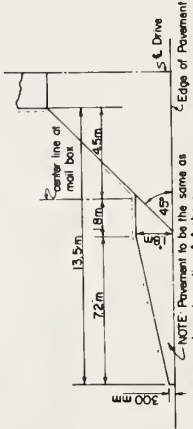
PLAN



SECTION A-A



SECTION B-B



COMBINED DRIVEWAY & MAIL BOX APPROACH
 SHOWN IN SECTION A-A ABOVE
 STA 17+93.2 LI 8 STA 18+42.2 LI
 4 Aggregate Base
 0.4 Aggregate Base

RESIDENCE	FIELD
50mm 404 Asph Conc. for driveways; 150mm 304 Aggregate Base with 408 Bituminous Prime Coat or 200mm 304 Aggregate Base	150mm 304 Aggregate Base

Figure 6. Driveway Typical Section & Superelevation Tables

GENERAL SUMMARY									
PERRY COUNTY									
PER-100-344 (11.11.11)									
Metric									
15									
38									
ITEM	QUANTITY	UNIT	DESCRIPTION						
201	Lump		Clearing and grubbing						
202	5064	m ²	Subgrade Compaction						
203	616	m ²	Water						
204	20	Lump	Pipe removed over 450 mm						
205	177	m	Structure removed						
206	2296	m ³	Embankment						
207	2751	m ³	Embankment using granular material or rock as per plan						
208	25984	m ³	Embankment using granular material or rock as per plan						
209	1140	m ³	Traffic compacted surface type A or B						
210	1140	m ³	Traffic compacted surface type C						
211	160.02	m	Guard rail, type 5						
212	4	Each	Anchor base slab						
213	8	Each	Guard posts						
214	2703	m ²	100mm Concrete walk						
215	50	m	DRAINAGE						
216	50	m	150 mm conduit type B						
217	30	m	150 mm conduit type C						
218	30	m	150 mm conduit type D						
219	30	m	150 mm conduit type E						
220	30	m	200 mm conduit type B						
221	30	m	200 mm conduit type C						
222	30	m	200 mm conduit type D						
223	30	m	200 mm conduit type E						
224	1244	m	310 mm conduit type B						
225	242	m	310 mm conduit type C						
226	272	m	310 mm conduit type D						
227	4.4	m	310 mm conduit type E						
228	4.4	m	450 mm conduit type B						
229	9.6	m	450 mm conduit type C						
230	17.4	m	450 mm conduit type D						
231	45.4	m	450 mm conduit type E						
232	46	m	707.01						
233	380	m	706.02						
234	380	m	706.02 Cl. III or 707.13						
235	42.0	m	5050 mm x 3070 mm conduit type A 707.05 (3.51 mm - 4.27 mm) as per plan						
236	1	Each	Manhole requisited to grade						
237	1	Each	Catch basin No. 2-B						
238	1	Each	Catch basin No. 3-A						
239	1	Each	Catch basin No. 4-A						
240	1	Each	Catch basin No. 5-A						
241	21.4	m	Concrete masonry						
242	21.4	m	150mm Deep pipe underdrains						
243	540.4	m	150mm unclassified pipe underdrains						
244	50	m	707.01 Type III or 707.12 as per plan						
245	7	m ²	EROSION CONTROL						
246	7	m ²	Barrap using 150 mm reinforced concrete slab						
247	256	m ³	Rock channel protection type A						
248	20207	m ²	Seeding and mulching						
249	183	tonne	Commercial fertilizer (12-12-12)						
250	9.17	tonne	Agricultural liming						
251	801	m ²	Sodding						
252	123	m	PAVEMENT						
253	570	m ³	Sub type 6						
254	378	m ³	Blumous aggregate base 702.01 (70.85 or AC-20) or 702.09 RT-11 or RT-12						
255	446	m ³	Aggregate base 70.85 or AC-20						
256	446	m ³	Asphalt concrete (70.85 or AC-20)						
257	20	m ³	Asphalt concrete (70.85 or AC-20)						
258	408	Inters	Blumous prime coat 702.02 or 702.03						
259	187	Inters	Blumous prime coat 702.02 or 702.03						
260	187	Inters	Blumous prime coat 702.02 or 702.03						
261	187	Inters	Blumous prime coat 702.02 or 702.03						
262	187	Inters	Blumous prime coat 702.02 or 702.03						
263	187	Inters	Blumous prime coat 702.02 or 702.03						
264	187	Inters	Blumous prime coat 702.02 or 702.03						
265	187	Inters	Blumous prime coat 702.02 or 702.03						
266	187	Inters	Blumous prime coat 702.02 or 702.03						
267	187	Inters	Blumous prime coat 702.02 or 702.03						
268	187	Inters	Blumous prime coat 702.02 or 702.03						
269	187	Inters	Blumous prime coat 702.02 or 702.03						
270	187	Inters	Blumous prime coat 702.02 or 702.03						
271	187	Inters	Blumous prime coat 702.02 or 702.03						
272	187	Inters	Blumous prime coat 702.02 or 702.03						
273	187	Inters	Blumous prime coat 702.02 or 702.03						
274	187	Inters	Blumous prime coat 702.02 or 702.03						
275	187	Inters	Blumous prime coat 702.02 or 702.03						
276	187	Inters	Blumous prime coat 702.02 or 702.03						
277	187	Inters	Blumous prime coat 702.02 or 702.03						
278	187	Inters	Blumous prime coat 702.02 or 702.03						
279	187	Inters	Blumous prime coat 702.02 or 702.03						
280	187	Inters	Blumous prime coat 702.02 or 702.03						
281	187	Inters	Blumous prime coat 702.02 or 702.03						
282	187	Inters	Blumous prime coat 702.02 or 702.03						
283	187	Inters	Blumous prime coat 702.02 or 702.03						
284	187	Inters	Blumous prime coat 702.02 or 702.03						
285	187	Inters	Blumous prime coat 702.02 or 702.03						
286	187	Inters	Blumous prime coat 702.02 or 702.03						
287	187	Inters	Blumous prime coat 702.02 or 702.03						
288	187	Inters	Blumous prime coat 702.02 or 702.03						
289	187	Inters	Blumous prime coat 702.02 or 702.03						
290	187	Inters	Blumous prime coat 702.02 or 702.03						
291	187	Inters	Blumous prime coat 702.02 or 702.03						
292	187	Inters	Blumous prime coat 702.02 or 702.03						
293	187	Inters	Blumous prime coat 702.02 or 702.03						
294	187	Inters	Blumous prime coat 702.02 or 702.03						
295	187	Inters	Blumous prime coat 702.02 or 702.03						
296	187	Inters	Blumous prime coat 702.02 or 702.03						
297	187	Inters	Blumous prime coat 702.02 or 702.03						
298	187	Inters	Blumous prime coat 702.02 or 702.03						
299	187	Inters	Blumous prime coat 702.02 or 702.03						
300	187	Inters	Blumous prime coat 702.02 or 702.03						
301	187	Inters	Blumous prime coat 702.02 or 702.03						
302	187	Inters	Blumous prime coat 702.02 or 702.03						
303	187	Inters	Blumous prime coat 702.02 or 702.03						
304	187	Inters	Blumous prime coat 702.02 or 702.03						
305	187	Inters	Blumous prime coat 702.02 or 702.03						
306	187	Inters	Blumous prime coat 702.02 or 702.03						
307	187	Inters	Blumous prime coat 702.02 or 702.03						
308	187	Inters	Blumous prime coat 702.02 or 702.03						
309	187	Inters	Blumous prime coat 702.02 or 702.03						
310	187	Inters	Blumous prime coat 702.02 or 702.03						
311	187	Inters	Blumous prime coat 702.02 or 702.03						
312	187	Inters	Blumous prime coat 702.02 or 702.03						
313	187	Inters	Blumous prime coat 702.02 or 702.03						
314	187	Inters	Blumous prime coat 702.02 or 702.03						
315	187	Inters	Blumous prime coat 702.02 or 702.03						
316	187	Inters	Blumous prime coat 702.02 or 702.03						
317	187	Inters	Blumous prime coat 702.02 or 702.03						
318	187	Inters	Blumous prime coat 702.02 or 702.03						
319	187	Inters	Blumous prime coat 702.02 or 702.03						
320	187	Inters	Blumous prime coat 702.02 or 702.03						
321	187	Inters	Blumous prime coat 702.02 or 702.03						
322	187	Inters	Blumous prime coat 702.02 or 702.03						
323	187	Inters	Blumous prime coat 702.02 or 702.03						
324	187	Inters	Blumous prime coat 702.02 or 702.03						
325	187	Inters	Blumous prime coat 702.02 or 702.03						
326	187	Inters	Blumous prime coat 702.02 or 702.03						
327	187	Inters	Blumous prime coat 702.02 or 702.03						
328	187	Inters	Blumous prime coat 702.02 or 702.03						
329	187	Inters	Blumous prime coat 702.02 or 702.03						
330	187	Inters	Blumous prime coat 702.02 or 702.03						
331	187	Inters	Blumous prime coat 702.02 or 702.03						
332	187	Inters	Blumous prime coat 702.02 or 702.03						
333	187	Inters	Blumous prime coat 702.02 or 702.03						
334	187	Inters	Blumous prime coat 702.02 or 702.03						
335	187	Inters	Blumous prime coat 702.02 or 702.03						
336	187	Inters	Blumous prime coat 702.02 or 702.03						
337	187	Inters	Blumous prime coat 702.02 or 702.03						
338	187	Inters	Blumous prime coat 702.02 or 702.03						
339	187	Inters	Blumous prime coat 702.02 or 702.03						
340	187	Inters	Blumous prime coat 702.02 or 702.03						
341	187	Inters	Blumous prime coat 702.02 or 702.03						
342	187	Inters	Blumous prime coat 702.02 or 702.03						
343	187	Inters	Blumous prime coat 702.02 or 702.03						
344	187	Inters	Blumous prime coat 702.02 or 702.03						
345	187	Inters	Blumous prime coat 702.02 or 702.03						
346	187	Inters	Blumous prime coat 702.02 or 702.03						
347	187	Inters	Blumous prime coat 702.02 or 702.03						
348	187	Inters	Blumous prime coat 702.02 or 702.03						
349	187	Inters	Blumous prime coat 702.02 or 702.03						
350	187	Inters	Blumous prime coat 702.02 or 702.03						
351	187	Inters	Blumous prime coat 702.02 or 702.03						
352	187	Inters	Blumous prime coat 702.02 or 702.03						
353	187	Inters	Blumous prime coat 702.02 or 702.03						
354	187	Inters	Blumous prime coat 702.02 or 702.03						
355	187	Inters	Blumous prime coat 702.02 or 702.03						
356	187	Inters	Blumous prime coat 702.02 or 702.03						
357	187	Inters	Blumous prime coat 702.02 or 702.03						
358	187	Inters	Blumous prime coat 702.02 or 702.03						
359	187	Inters	Blumous prime coat 702.02 or 702.03						
360	187	Inters	Blumous prime coat 702.02 or 702.03						
361	187	Inters	Blumous prime coat 702.02 or 702.03						
362	187	Inters	Blumous prime coat 702.02 or 702.03						
363	187	Inters	Blumous prime coat 702.02 or 702.03						
364	187	Inters	Blumous prime coat 702.02 or 702.03						
365	187	Inters	Blumous prime coat 702.02 or 702.03						
366	187	Inters	Blumous prime coat 702.02 or 702.03						
367	187	Inters	Blumous prime coat 702.02 or 702.03						
368	187	Inters	Blumous prime coat 702.02 or 702.03						
369	187	Inters	Blumous prime coat 702.02 or 702.03						
370	187	Inters	Blumous prime coat 702.02 or 702.03						
371	187	Inters	Blumous prime coat 702.02 or 702.03						
372	187	Inters	Blumous prime coat 702.02 or 702.03						
373	187	Inters	Blumous prime coat 702.02 or 702.03						
374	187	Inters	Blumous prime coat 702.02 or 702.03						
375	187	Inters	Blumous prime coat 702.02 or 702.03						
376	187	Inters	Blumous prime coat 702.02 or 702.03						
377	187	Inters	Blumous prime coat 702.02 or 702.03						
378	187	Inters	Blumous prime coat 702.02 or 702.03						
379	187	Inters	Blumous prime coat 702.02 or 702.03						
380	187	Inters	Blumous prime coat 702.02 or 702.03						
381	187	Inters	Blumous prime coat 702.02 or 702.03						
382	187	Inters	Blumous prime coat 702.02 or 702.03						
383	187	Inters	Blumous prime coat 702.02 or 702.03						
384	187	Inters	Blumous prime coat 702.02 or 702.03						
385	187	Inters	Blumous prime coat 702.02 or 702.03						
386	187	Inters	Blumous prime coat 702.02 or 702.03						
387	187	Inters	Blumous prime coat 702.02 or 702.03						
388	187	Inters	Blumous prime coat 702.02 or 702.03						
389	187	Inters	Blumous prime coat 702.02 or 702.03						
390	187	Inters	Blumous prime coat 702.02 or 702.03						
391	187	Inters	Blumous prime coat 702.02 or 702.03						
392	187	Inters	Blumous prime coat 702.02 or 702.03						
393	187	Inters	Blumous prime coat 702.02 or 702.03						
394	187	Inters	Blumous prime coat 702.02 or 702.03						
395	187	Inters	Blumous prime coat 702.02 or 702.03						
396	187	Inters	Blumous prime coat 702.02 or 702.03						
397	187	Inters	Blumous prime coat 702.02 or 702.03						
398	187	Inters	Blumous prime coat 702.02 or 702.03						
399	187	Inters	Blumous prime coat 702.02 or 702.03						
400	187	Inters	Blumous prime coat 702.02 or 702.03						
401	187	Inters	Blumous prime coat 702.02 or 702.03						
402	187	Inters	Blumous prime coat 702.02 or 702.03						
403	187	Inters	Blumous prime coat 702.02 or 702.03						
404	187	Inters	Blumous prime coat 702.02 or 702.03						
405	187	Inters	Blumous prime coat 702.02 or 702.03						
406	187	Inters	Blumous prime coat 702.02 or 702.03						
407	187	Inters	Blumous prime coat 702.02 or 702.03						
408	187	Inters	Blumous prime coat 702.02 or 702.03						
409	187	Inters	Blumous prime coat 702.02 or 702.03						
410	187	Inters	Blumous prime coat 702.02 or 702.03						
411	187	Inters	Blumous prime coat 702.02 or 702.03						
412	187	Inters	Blumous prime coat 702.02 or 702.03						
413	187	Inters	Blumous prime coat 702.02 or 702.03						
414	187	Inters	Blumous prime coat 702.02 or 702.03						
415	187	Inters	Blumous prime coat 702.02 or 702.03						
416	187	Inters	Blumous prime coat 702.02 or 702.03						
417	187	Inters	Blumous prime coat 702.02 or 702.03						
418	187	Inters	Blumous prime coat 702.02 or 702.03						
419	187	Inters	Blumous prime coat 702.02 or 702.03						
420	187	Inters	Blumous prime coat 702.02 or 702.03						

Line & Profile Sheet (Sample 1)

Figure 9. Line & Profile Sheet (Sample 2)

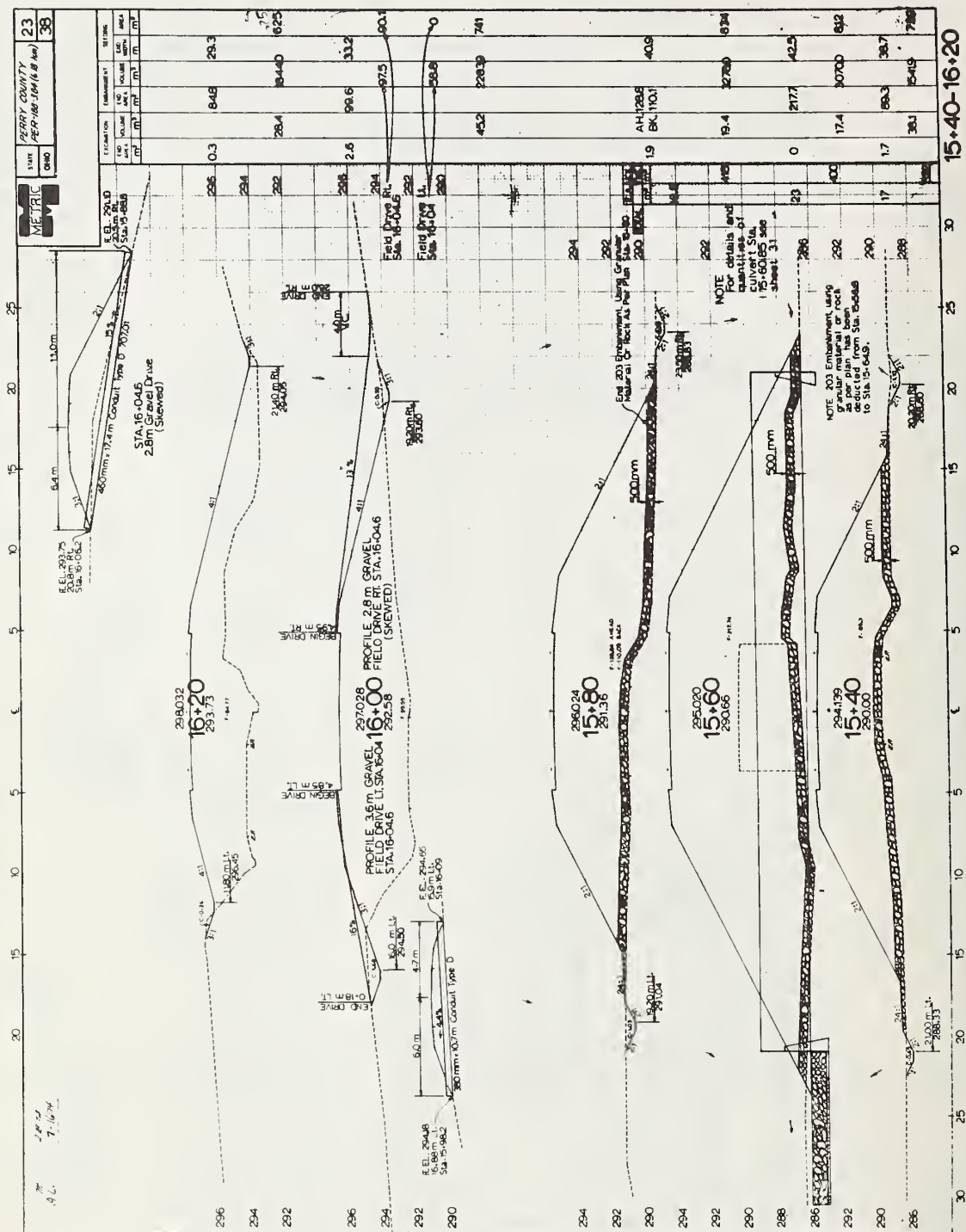


Figure 10. Cross Section Sheet (typical)

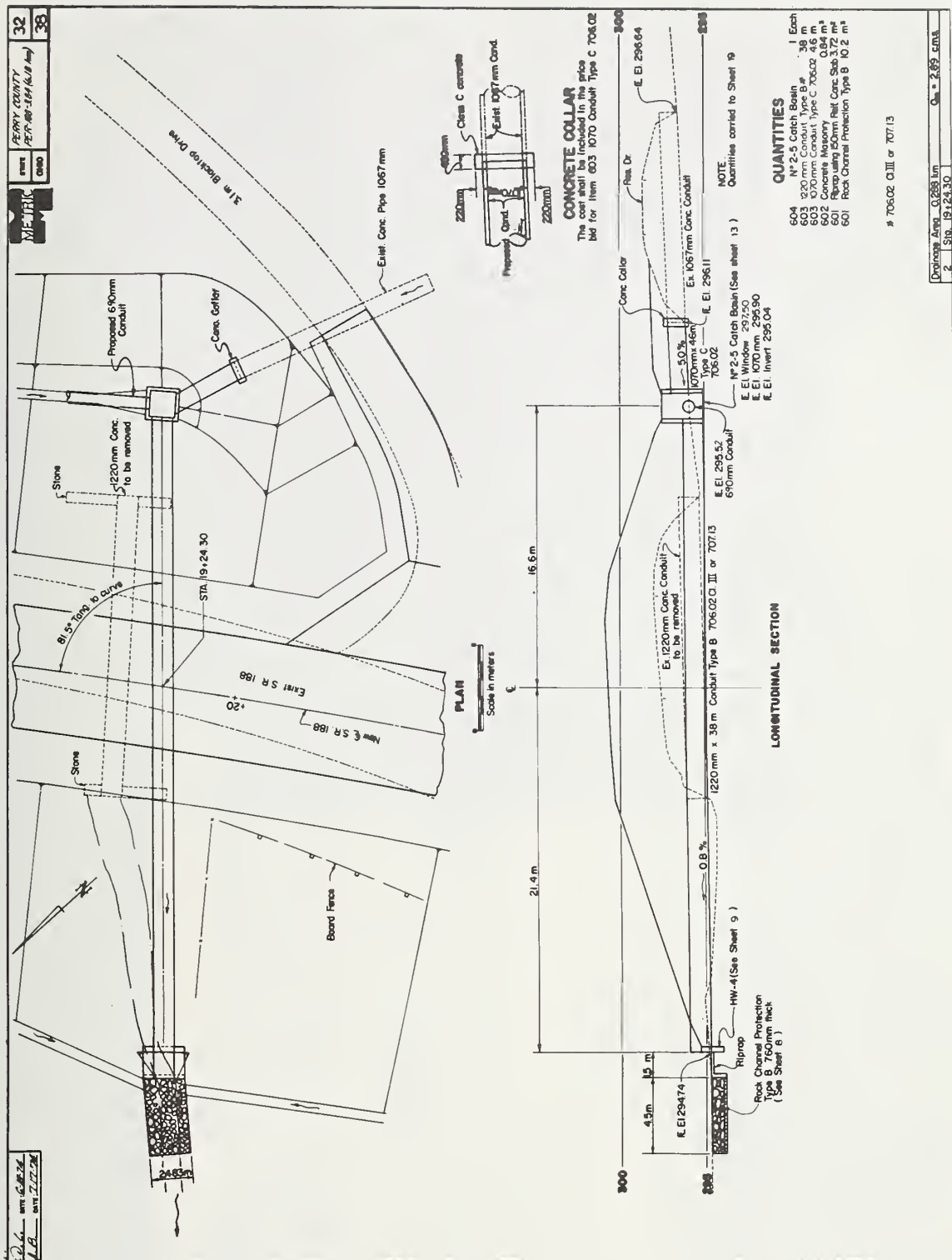


Figure 11. Culvert Detail Sheet
167

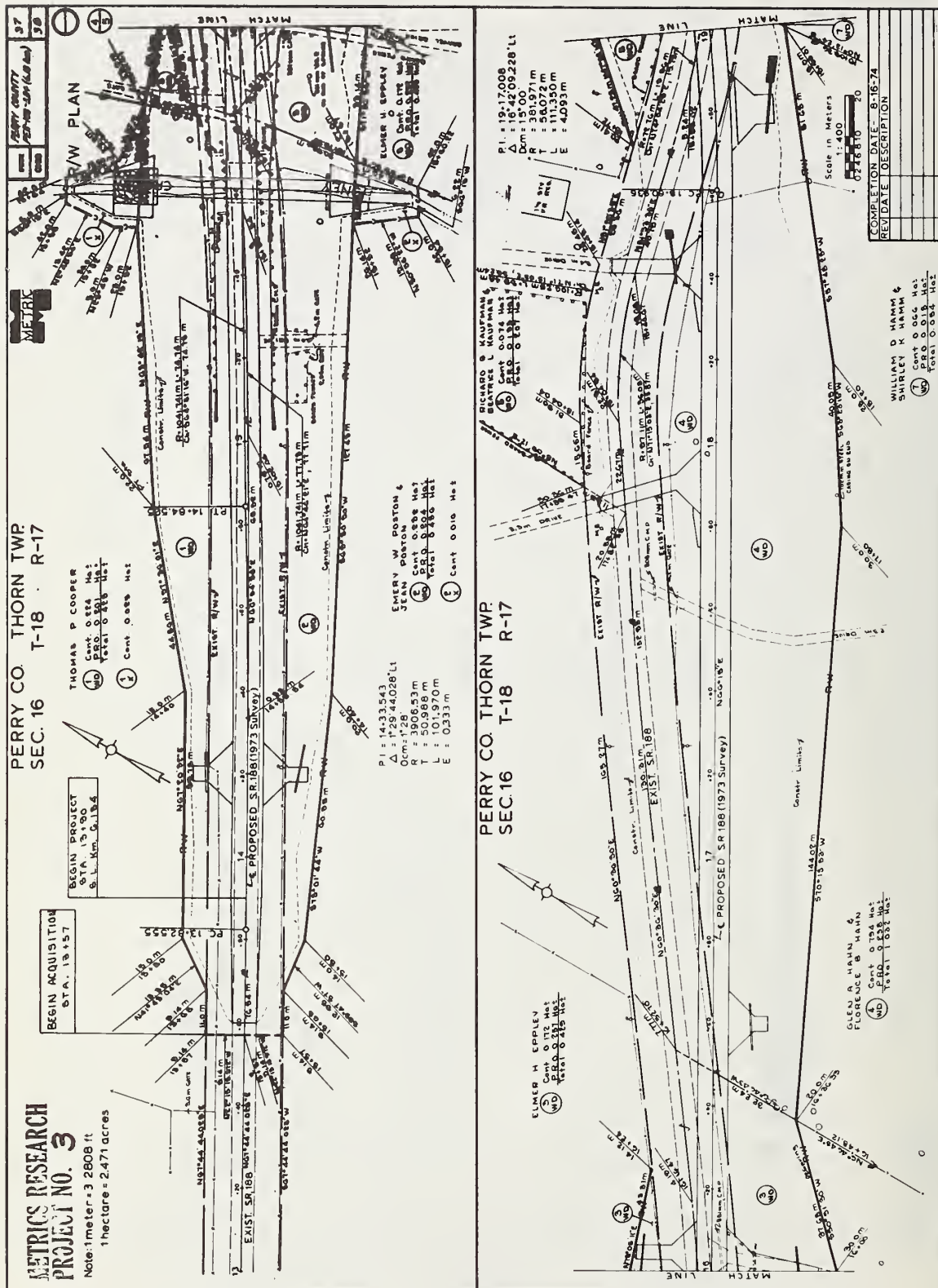


Figure 12.

Right-of-Way Sheet (typical)

TE 662

.A3

no. FHWA-RD- 7

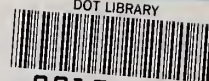
BOROWE

W. B. Borowe

REN-DAT

24. State

DOT LIBRARY



00177726

